

Understanding Public Responses to Domestic Threats

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Abstract

The overall goal of this report is to improve understanding of public responses to domestic threats. Project 1 focuses on pandemic influenza and dirty bomb threats, aiming to understand the role of emotions in anticipated behavioural responses. Project 2 examines a situation in which people are evacuated from a community to avoid exposure to radioactive fallout from an upwind nuclear explosion. The project aims to understand the factors that affect people's decisions about how long to wait until returning to their homes, given the gradual decline in radiation levels resulting from radioactive decay.

First, we present an overview of each problem, by presenting models summarizing scientific knowledge. The resulting models use the logic of influence diagrams (Clemens, 1997; Fischhoff, 2000) with nodes reflecting relevant variables affecting the risk, and mitigating it, and links showing how they are connected. The models differ from traditional risk models, because they include emotional and behavioural components that affect how a risk event unfolds. Project 1 models concern the interplay between emotional and behavioural responses to domestic threats, focusing on fear and anger. The model for project 2 concerns the health, social, and economic factors that may affect people's decisions to return to a community with residual radiation levels that elevate cancer risk.

Second, we report on surveys with Canadian and U.S. participants, based on these models. For project 1, we presented participants with scenarios describing the risks and mitigation strategies for pandemic influenza and radiological dispersion devices. We examined the independent relationship of fear and anger with different responses to these scenarios. We found that, independent of anger and trait emotions, fear was related to seeing more risk of morbidity and mortality, and predicting less resilience, more compliance with mitigation strategies, and higher likelihood of being absent from work in case of pandemic influenza. However, anger showed no significant relationship with these variables, after controlling for fear and trait emotions.

For project 2, the survey examined people's decisions about how long to stay evacuated before returning to a fallout-contaminated neighbourhood. We found that those decisions were affected by the cancer risk of radioactive fallout, as well as the availability of free housing in the evacuation zone. Although cancer risk was rated as the most important factor affecting these decisions (as was the overall health of participants and their household members), other characteristics of the household, the neighbourhood, and temporary housing were also rated as relatively important.

Résumé

Le présent rapport a pour objectif global de faire mieux comprendre les réactions du public aux menaces nationales. Le projet 1, qui se concentre sur les risques de pandémie de grippe et d'utilisation de bombe sale, vise à éclaircir le rôle des émotions dans les réactions comportementales attendues. Le projet 2, pour sa part, décrit un scénario où l'on évacue des personnes d'une collectivité pour prévenir leur exposition aux retombées radioactives d'une explosion nucléaire; il vise à explorer les facteurs qui influent sur les décisions des personnes concernant le temps à attendre avant de retourner à la maison, compte tenu de la baisse graduelle des taux de rayonnement résultant de la désintégration radioactive.

Nous présenterons d'abord un survol de chaque problème en nous appuyant sur des modèles résumant les connaissances scientifiques dans le domaine. Les modèles reposent sur la logique des diagrammes d'influence (Clemens, 1997; Fischhoff, 2000), dont les nœuds correspondent aux variables pertinentes qui influent sur le risque et le réduisent, et sur les liens montrant leurs interrelations. Ces modèles diffèrent des modèles de risque classiques, car ils tiennent compte des facteurs émotionnels et comportementaux qui influent sur l'issue d'un incident. Les modèles du projet 1, qui concernent les liens réciproques entre les réactions émotionnelles et comportementales aux menaces nationales, se concentrent sur la peur et la colère. Le modèle du projet 2 concerne les facteurs sanitaires, sociaux et économiques qui influent sur la décision des personnes de retourner vivre dans une collectivité dont les taux de rayonnement résiduel augmentent le risque de cancer.

Ensuite, nous présenterons les études menées au Canada et aux États-Unis à l'aide de ces modèles. Dans le projet 1, nous avons présenté aux participants des scénarios décrivant les risques de pandémie de grippe et d'utilisation de dispositif de dispersion radiologique, ainsi que les stratégies d'atténuation de ces risques. En examinant la relation indépendante entre la peur et la colère et les différentes réactions aux scénarios, nous avons noté qu'indépendamment des émotions liées aux traits de colère, la peur était associée à une augmentation du risque perçu de morbidité et de mortalité, de la conformité aux stratégies d'atténuation et de l'absentéisme au travail ainsi qu'à une diminution de la résilience en cas de pandémie de grippe. Cependant, dans le cas de la colère, nous n'avons relevé aucune relation notable avec ces variables après ajustement en fonction des émotions liées aux traits de peur.

L'étude du projet 2 consistait à observer les décisions des personnes concernant le temps à attendre avant de retourner vivre dans un quartier contaminé par des retombées radioactives. Nous avons noté que ces décisions sont influencées par le risque de cancer dû aux retombées radioactives ainsi que par l'accès à des logements gratuits dans la zone évacuée. Bien que le risque de cancer se soit avéré le plus important facteur à influencer sur ces décisions (de même que l'état de santé général des participants et des membres de leur ménage), d'autres caractéristiques du ménage, du quartier et des logements temporaires se sont aussi révélées importantes.

Executive Summary

Domestic threats can undermine public morale at home and abroad, potentially affecting people's ability to respond. Emotional and behavioural responses must be considered in formulating a behaviourally realistic risk management approach, in order to ensure that it addresses issues relevant to public welfare, while informing the public of the issues identified by the expert community (within the constraints of what can be communicated without compromising the public's own welfare to an intelligent adversary).

Here, we study public responses to problems falling into the general category of domestic threats. We cover two projects. Project 1 focuses on pandemic influenza and dirty bomb threats, aiming to understand the role of emotions in anticipated behavioural responses. Project 2 focuses on nuclear threats, aiming to understand the factors that affect people's decisions about how long to wait until returning home after fallout contamination from an upwind nuclear bomb explosion.

First, we present an overview of each problem, by presenting models summarizing scientific knowledge. The resulting models use the logic of influence diagrams (Clemens, 1997; Fischhoff, 2000) with nodes reflecting relevant variables affecting the risk, and mitigating it, and links showing how they are connected. The models differ from traditional risk models, because they include emotional and behavioural components that affect how a risk unfolds. Second, we present surveys, inspired by the models, aiming to better understand people's responses to domestic threats. This steps represented normative and descriptive analyses based on decision theory (von Winterfeldt & Edwards, 1986; Hastie & Dawes, 2002; Yates, 1990).

Project 1 models focus on the interplay between emotional and behavioural responses to domestic threats, focusing on fear and anger – two negative emotions that are evoked by domestic threats. Although early research assumed that negative emotions would have similar effects on cognition, a growing body of literature suggests that fear and anger actually have independent, and differential effects on people's cognitive responses. For example, while fear increases perceptions of risk, anger decreases perceptions of risk (Lerner et al., 2003). This result is explained by the Appraisal-Tendency Approach, which states that fear and anger are related to different appraisals, with, for example, fear being related to feeling low certainty and low personal control, and anger being related to feeling high certainty and high personal control.

The survey for project 1 presented participants with scenarios describing the risks and mitigation strategies for pandemic influenza and radiological dispersion devices. Canadian and U.S. participants reported on trait fear and trait anger, state fear and state anger experienced at baseline or before reading these scenarios, and state fear and state anger experienced after reading each of these scenarios. Both scenarios increased state fear and state anger, compared to baseline.

We examined the independent relationship of state fear and state anger experienced as a result of each scenario with responses to each scenario. We found that, independent of anger, fear was related to seeing more risk of morbidity and mortality, and predicting less resilience, more compliance with mitigation strategies, as well as higher likelihood of being absent from work in case of pandemic influenza. However, anger showed no significant relationship with these variables, after controlling for fear.

Project 2 examines a situation in which people are evacuated from a community to avoid exposure to radioactive fallout from an upwind nuclear explosion. The project 2 survey measured the factors that affect people's decisions about how long to wait until returning to their contaminated community, given the gradual decline in radiation levels resulting from radioactive decay.

Canadian and U.S. participants were randomly assigned to conditions of low risk or high risk of cancer from radioactive fallout. Subsequently, they were asked to decide how long they would want to wait until moving back, if free temporary housing were available in the evacuation zone, and if it were not.

We found that those decisions were affected by cancer risk of radioactive fallout, as well as the availability of free housing. Although cancer risk was rated as the most important factor affecting these decisions (as was the overall health of participants and their household members), other characteristics of the household, the neighbourhood and temporary housing were also rated as relatively important.

Sommaire

Les menaces nationales peuvent affecter le moral du public, aussi bien au pays qu'à l'étranger, de même que la capacité de réponse des personnes. Les réactions émotionnelles et comportementales doivent être prises en considération dans l'élaboration d'une approche de gestion des risques pour que celle-ci soit réaliste sur le plan comportemental et qu'elle s'attaque aux questions ayant une incidence sur le bien-être du public tout en informant la population des questions soulevées par les experts (dans la mesure de ce qui peut être communiqué sans compromettre la sécurité du public en présence d'un adversaire « intelligent »).

Nous examinerons les réactions du public face à des problèmes correspondant à la catégorie générale des menaces nationales par l'entremise de deux projets. Le projet 1, qui se concentre sur les menaces de pandémie de grippe et d'utilisation de bombe sale, vise à éclaircir le rôle des émotions dans les réactions comportementales attendues. Le projet 2, qui porte sur les menaces nucléaires, vise à explorer les facteurs qui influent sur les décisions des personnes concernant le temps à attendre avant de retourner à la maison après une contamination due aux retombées radioactives d'une explosion nucléaire.

Nous présenterons d'abord un survol de chaque problème en nous appuyant sur des modèles résumant les connaissances scientifiques dans le domaine. Les modèles reposent sur la logique des diagrammes d'influence (Clemens, 1997; Fischhoff, 2000), dont les nœuds correspondent aux variables pertinentes qui influent sur le risque et le réduisent, et sur les liens montrant leurs interrelations. Ces modèles diffèrent des modèles de risque classiques, car ils tiennent compte des facteurs émotionnels et comportementaux qui influent sur l'issue d'un incident. Ensuite, nous présenterons des études étayées sur ces modèles qui visent à éclaircir les réactions des personnes aux menaces nationales. Cette partie comprendra des analyses normatives et descriptives fondées sur la théorie de la décision (von Winterfeldt et Edwards, 1986; Hastie et Dawes, 2002; Yates, 1990).

Les modèles du projet 1, qui concernent les liens réciproques entre les réactions émotionnelles et comportementales aux menaces nationales, se concentrent sur la peur et la colère – deux émotions négatives provoquées par les menaces nationales. Même si dans les premières recherches, on présumait que les émotions négatives avaient des effets semblables sur la cognition, de plus en plus de publications portent à croire que la peur et la colère ont des effets indépendants, et par conséquent différents, sur les réponses cognitives des personnes. Par exemple, tandis que la peur augmente le risque perçu, la colère réduit cette perception du risque (Lerner et coll., 2003). Cette observation s'explique par la théorie des jugements, selon laquelle la peur et la colère produisent des jugements différents. Par exemple, la peur est liée à un sentiment d'incertitude et de faible contrôle personnel, tandis que la peur est associée à un sentiment de forte certitude et de contrôle personnel élevé.

Dans le projet 1, nous avons présenté aux participants des scénarios décrivant les risques de pandémie de grippe et d'utilisation de dispositif de dispersion radiologique, ainsi que les stratégies d'atténuation de ces risques. Les participants canadiens et américains ont indiqué leur trait de peur et de colère, leur état de peur et de colère de départ (c.-à-d. avant la lecture des scénarios) et leur état de peur et de colère après la lecture de chacun des scénarios. Les deux scénarios ont entraîné une augmentation de l'état de peur et de colère par rapport au départ.

En examinant la relation indépendante entre l'état de peur et de colère observé après la lecture de chaque scénario et les réactions aux scénarios, nous avons noté qu'indépendamment de la colère, la peur était associée à une augmentation du risque perçu de morbidité et de mortalité, de la conformité aux stratégies d'atténuation et de l'absentéisme au travail ainsi qu'à une diminution de la résilience en cas de pandémie de grippe. Cependant, dans le cas de la colère, nous n'avons relevé aucune relation notable avec ces variables après ajustement en fonction de la peur.

Le projet 2 décrit un scénario où l'on évacue des personnes d'une collectivité pour prévenir leur exposition aux retombées radioactives d'une explosion nucléaire; il vise à explorer les facteurs qui influent sur les décisions des personnes concernant le temps à attendre avant de retourner à la maison, compte tenu de la baisse graduelle des taux de rayonnement résultant de la désintégration radioactive.

Les participants canadiens et américains ont été répartis aléatoirement dans des groupes où le risque de cancer découlant des retombées radioactives était élevé ou faible. Après avoir lu leur scénario, les participants devaient décider combien de temps attendre avant de retourner à la maison si des logements gratuits étaient offerts dans la zone évacuée et s'ils ne l'étaient pas.

Selon nos observations, les décisions ont été influencées par le risque de cancer découlant des retombées radioactives ainsi que par l'accès à des logements gratuits. Bien que le risque de cancer se soit avéré comme le plus important facteur à influencer sur ces décisions (de même que l'état de santé général des participants et des membres de leur ménage), d'autres caractéristiques du ménage, du quartier et des logements temporaires se sont aussi révélées importantes.

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1 Background and Aim

Domestic threats can undermine public morale at home and abroad. The direct route to this end point involves instilling fear and anger, thereby undermining citizens' well-being, ability to function, and confidence in their way of life. One indirect route involves disrupting normal life, by interfering with economic activity, travel, education, leisure, elections, and the like. A second indirect route involves alienating people from their leaders, by throwing doubt on the two cornerstones of trust: competence and honesty. A domestic threat (or even false alarm) may leave citizens feeling that their authorities not only failed to protect them, but also denied them the ability to protect themselves (including material resources and candid situation assessments). Such beliefs would also threaten the public's willingness to cooperate with military personnel. A third indirect route involves turning citizens against one another, by creating the feeling that they are receiving differential protection, or even that some are profiting from a situation, where others are suffering.

Emotional and behavioral responses must be considered in formulating a behaviorally realistic risk management approach, in order to ensure that it addresses issues relevant to public welfare, while informing the public of the issues identified by the expert community (within the constraints of what can be communicated without compromising the public's own welfare to an intelligent adversary). Thus, the stakes are high on properly understanding public responses to domestic threats.

In this report, we present two projects using survey methods to improve our understanding of the public's emotional and behavioral responses to domestic threats. The first examines the interplay of emotional and cognitive responses, and the second behavioral responses. The specific domestic threats were chosen to reflect current domestic threats, including pandemic influenza and radiological dispersion devices (dirty bombs) for project 1, and radioactive fallout from a nuclear bomb explosion for project 2. Thus, the results of both projects should be relevant to the design of behaviorally realistic risk management.

For each problem, we take two steps necessary to understand public responses. First, we conduct a normative analysis of the information relevant to the decision, summarizing scientific understanding of the problem. Second, we conduct a descriptive analysis of public responses, by surveying citizens about topics identified in the first step. This approach is based on decision theory (von Winterfeldt & Edwards, 1986; Hastie & Dawes, 2002; Yates, 1990). We have applied it to risks of sexually transmitted infections (Fischhoff et al., 1998), cryptosporidium in drinking water (Casman et al., 2000), breast implants (Byram et al., 2001), and climate change (Casman et al., 2001), among other things (M.G. Morgan et al., 2001). Like all modeling, their creation is an exercise in judgment, involving iterative review by experts in different domains.

For the first step, we began with summarizing research results into analytically tractable terms, reflecting situations where risk levels depend on human behavior. The resulting models use the logic of influence diagrams (Clemens, 1997; Fischhoff, 2000) with nodes reflecting relevant variables affecting the risk, and mitigating it, and links showing how they are connected. Influence diagrams allow accommodating diverse forms of knowledge, including observation, judgment, and theory. Thus, these models differ from traditional risk models, because they include emotional and behavioral components that affect how a risk unfolds. As such, these models may help to identify more behaviorally realistic responses to threats.

For example, a common misconception is that people panic in time of crisis, behaving irrationally at the individual and group level (Fischhoff, 2005a; Tierney, 2003). That belief is contradicted by a large body of research, which has found that people respond reasonably, even bravely, to such challenges (Glass, 2001).

Although computational expertise is required in order to produce quantitative predictions, a visualization of the risk domain may help to inform an integrated risk management approach (see, for example, Department of National Defence, 2002; 2004). Here, we used the models to develop surveys examining public responses to risk messages about specific domestic threats. Combined, the results of this work may guide command decision making, strategy design, risk management, and the development and evaluation of risk communication.

2. Project 1: The role of emotions in responses to domestic threats

2.1. Introduction

Domestic threats trigger intense thought as well as strong negative emotions. A growing academic literature considers the interplay between cognitive and emotional responses (see, for example, Lerner & Keltner, 2000; Loewenstein & Lerner, 2002; Loewenstein et al., 2001). Originally, it was thought that positive emotions would lead to more optimistic thinking, while negative emotions would lead to pessimistic thinking (Johnson & Tversky, 1983). However, more recent research suggests that some specific emotions may have differential effects on cognitive responses, despite being of the same valence (Lerner et al., 2003; Lerner & Keltner, 2000, 2001; Tiedens & Linton, 2001). Fear and anger are two negative emotions evoked by terror attacks, with independent, and differential, effects on risk judgments (Lerner et al., 2003). That is, while fear is related to pessimistic risk judgments, anger is related to negative ones.

Here, we explore the differential roles of fear and anger in responses to domestic threats, using the appraisal tendency approach to specific emotions (Lerner & Keltner, 2000; Smith & Ellsworth, 1985). The appraisal-tendency approach identifies six characteristics that differentiate between specific emotions, even those of the same valence. Table 1 shows a comparison of fear and anger on these six characteristics, as presented by Lerner and Keltner (2000). According to the appraisal-tendency framework, fear and anger differ with regard to experienced certainty, anticipated effort, control, and responsibility. Fear is related to low certainty in the sense of seeing outcomes as predictable or comprehensible, anticipating high effort in reducing risk, seeing low levels of personal control, and medium levels of responsibility of others for negative outcomes. Angry people, on the other hand, tend to perceive high certainty, anticipate medium effort, high personal control in risky situations, and high levels of responsibility of others for negative outcomes.

In the next section, we present an overview model of pandemic influenza risks, and a detailed model predicting compliance with advice to use barrier methods such as masks. We subsequently present an overview model of risks related to radiological dispersion devices, and two detailed models predicting compliance with the advice to shelter at home and with the advice to evacuate. Each model incorporates emotion variables, and is discussed in detail below.

Table 1: Appraisals of fear and anger (Lerner & Keltner, 2000)

Characteristic	Fear	Anger
Certainty	Low	High
Pleasantness	Low	Low
Attentional activity	Medium	Medium
Anticipated effort	High	Medium
Control	Low	High
Responsibility of others	Medium	High
Appraisal tendency	Perceive negative events as unpredictable and under situational control	Perceive negative events as predictable, under human control, and brought about by others

2.2. Models of pandemic influenza risk

2.2.1. Overview model

In order to answer general questions about avian flu, risk managers must, more or less explicitly, create a model like the one shown in Figure 1. Although not intended to be the definitive pandemic model, it has benefited from review by a diverse group of experts in epidemiology and other fields relevant to pandemic influenza (e.g., sociology and political science). The nodes and links in the model represent variables and relationships, respectively. Such representation encourages conceptual clarity, facilitating discussions between experts and risk managers, highlighting expected consequences of pandemic influenza and strategies to reduce it, and suggesting topics that need to be communicated to the public.

Figure 1 was developed with input from medical experts and non-medical experts with specialties related to influenza attending PanDefense 1.0, a meeting about behavioral responses to an avian influenza outbreak organized by epidemiologist Larry Brilliant, currently Executive Director of the Google Foundation. Because the meeting was conducted under Chatham House Rule, we are not able to disclose the names of these experts. The model has been published by *Harvard Business Review* (Fischhoff, 2006) and *Journal of Risk and Uncertainty* (Fischhoff et al., 2006). The model has inspired a follow-up survey of experts on pandemic influenza, published in *Global Public Health* (Bruine de Bruin et al., 2006).

The blue nodes in Figure 1 reflect the outcomes of a pandemic, including the expected *morbidity*, *mortality* (with the link between the two representing the case-fatality rate), as well as *healthcare costs*, *non-health care economic costs*, and *social costs* (e.g., emotional reactions to losing loved ones, social fabric disruption, erosion of morale and community solidarity). The white ovals are chance nodes, reflecting the factors that determine those impacts, such as the *rate of spread*. The beige squares are action nodes, such as *barrier methods*. The *rate of spread* may be reduced by different interventions, such as *barrier methods*, which prevent spread, while maintaining social interaction. Figure 1 also includes factors that may improve the success of a barrier methods intervention. They include *disease surveillance*, which indicates when and where people should wear their barriers, and effective *communication*, aiming to improve *compliance* by giving information about how to effectively use the barrier methods. For example, without effective communications, people may contaminate themselves with pathogens while taking off the mask that was meant to protect them.

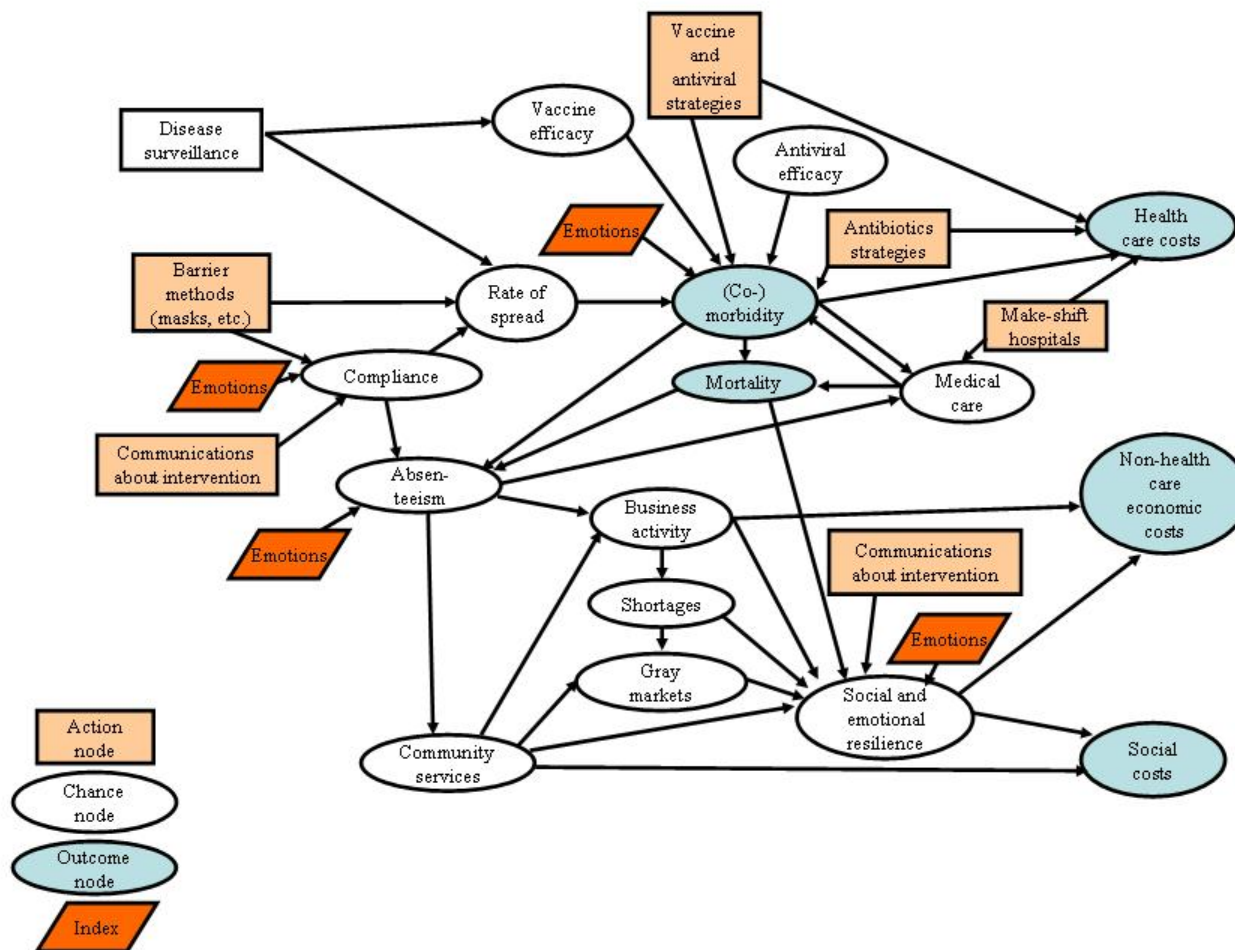


Figure 1: Avian flu model

The use of barrier methods may be augmented by the use of *vaccine and antiviral strategies*, to the extent that they are available. Their effectiveness also depends on *vaccine efficacy* and *antiviral efficacy*. Additional *antibiotics strategies* may be used to prevent secondary infections, such as pneumonia, which was a common killer during the influenza pandemic of 1918 (Barry, 2004). The quality of *medical care* will likely be threatened by an overwhelming demand due to high rates of morbidity. It may be improved by localized *make-shift hospitals*, set up in schools and other public buildings, but doing so will increase *health care costs*.

Furthermore, *morbidity* and *mortality* affect *absenteeism*, which reduces (public sector) *community services* (e.g., police, fire, mail, garbage pick-up) and (private sector) *business activities*. Reduced business activity would likely lead to *shortages* and *gray markets*, including both black market activities and grayer ones, like preferential treatment for families of officials or the wealthy. All of these factors affect people's *social and emotional resilience*, or their ability to emotionally cope with and live through the disaster, with the minimum of immediate- and long-term *non-healthcare economic costs* and other *social costs*. These processes also depend on the progress of the disease itself, as determined by the processes in the upper and right parts of the diagram. These are ones that most managers can only monitor, while focusing on the social processes over which they can exert some control. One of the strategies that may directly affect *social resilience* is presenting the population with timely and accurate *communications* about the progress of the pandemic and recommended mitigation strategies, while addressing effects of negative emotion on people's behavior.

The orange parallelograms in Figure 1 reflect emotions, presented as an index variable affecting specific factors: (1) (co-)morbidity, (2) compliance, (3) absenteeism, (4) social and emotional resilience. The specific emotions we focus on are fear and anger, which are predicted to have differential effects on these factors. Our predictions are based on the Appraisal-Tendency Framework (Lerner & Keltner, 2000), presented in Table 1. Where possible, we distinguish between the effects on actual versus perceived outcomes (i.e., the actual risk of co-morbidity versus the perceived risk of co-morbidity.)

First, with regard to co-morbidity, both fear and anger are expected to reduce overall health. Negative affect, including fear and anger, has been shown to reduce immune function (see Cohen & Herbert, 1996). As a result, it may make people more prone to infection with influenza. However, *perceptions* of the risk of co-morbidity may be higher in citizens who are fearful and lower in those who are angry (Lerner et al., 2003), because fear is related to feelings of low certainty, and anger to feelings of high certainty (Table 1).

Second, predictions with regard to compliance are less clear. As seen in Table 1, the appraisal-tendency approach (Lerner & Keltner, 2000) views fear as related to high anticipated effort, and feelings of low personal control. Thus, it is unclear whether fearful people will show more or less compliance. For anger, predictions are also unclear. Table 1 suggests that anger is related to medium anticipated effort and high personal control, suggesting that angry people should show better compliance. However, because anger also leads people to see less risk, angry people may not see the need to use barrier methods.

Third, with regard to absenteeism, we predict that fear will lead workers to stay at home, due to seeing more risk and low control over mitigating it (Table 1). Predictions for anger are less clear. Anger should lead to less absenteeism, because of its relationship to seeing less risk and more control over mitigating the risk (if they see it.) However, angry people may hold others responsible for the situation, and refuse to go to work out of spite.

Finally, fear and anger may also have differential effects on social and emotional resilience. Because fear is related to low certainty and low perceived control (Table 1), it is expected to reduce resilience. Anger should increase resilience if it leads people feel more in control over the situation (Table 1).

2.2.2. Detailed model of compliance with advice to use barrier methods

Figure 2 shows a detailed model predicting compliance with advice to use barrier methods, such as wearing masks, adapted from Fischhoff et al. (2006). Compliance to barrier methods, presented in a blue oval, is the outcome node for this model. Three intermediate-variable nodes, presented in green ovals, affect compliance: *feasibility* (whether people are able to use barrier methods,) *trust* (whether people believe that barrier methods will work) and *comprehension* (whether people understand risk information, as well as how and when to use barrier methods).

The factors that affect the *feasibility* of using barrier methods include (relatively stable) *user characteristics*, such as manual dexterity, conscientiousness, head structure (in terms of similarity to the manufacturers' prototype), and individual needs (smoking, eating). Feasibility also depends on transient health states, represented by (*co*)*morbidity*, including sickness from influenza, normal health problems (diabetes, asthma), and fatigue from tending sick relatives (or their dependents). And feasibility depends on *task demands*, both physical (breathing deeply) and psychological (serving customers, taking care of a child). Finally, feasibility depends on the *availability* of masks.

Factors that affect whether masks will be available include the existence of *government stockpiling* and *private stockpiling*. Private stockpiling depends on *household finances* influences, and are influenced, by *business activity* (before and during a pandemic), which in turn depends on ongoing *community services*, including those mentioned for Figure 1. Whether people create private stockpiles also depends on whether they believe that the government is creating sufficient stockpiles for them. Insufficient government stockpiling may lead to *gray markets* for masks, utilized by citizens to build private stockpiles.

Next, we focus on factors that affect trust, and how they connect to the variables that affect feasibility. Trust in the effectiveness of masks will be higher in a population with high *social and emotional resilience*, which should make people generally more trusting. Potential threats to social resilience are gray markets, addressing shortages illegally or unethically (e.g., favored treatment for officials' families), and failing *community services*. Social and emotional resilience itself affects whether business activities are ongoing, which indirectly influences the feasibility of mask use, through its effect on household finances, which determine the extent to which citizens can afford private stockpiling.

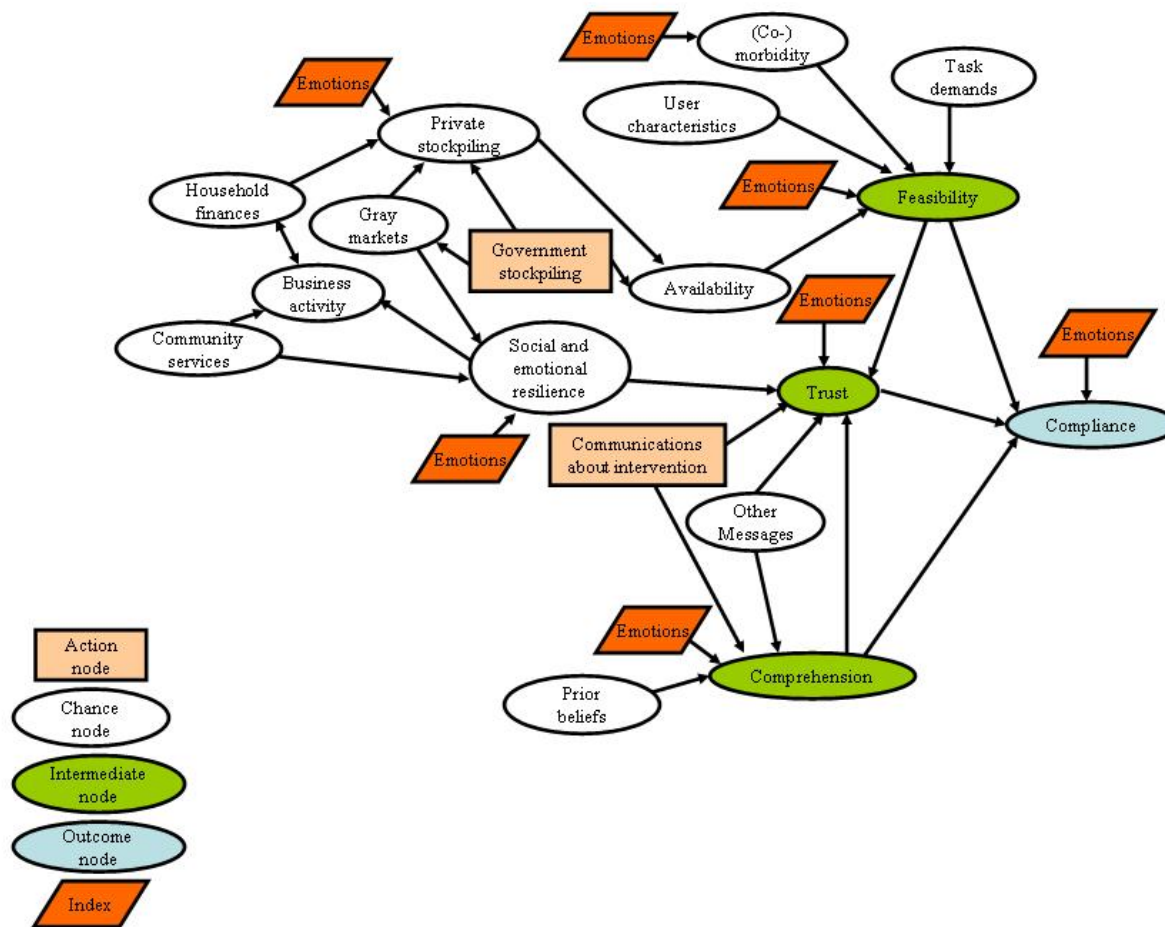


Figure 2: Model of compliance with barrier methods

Some of the factors that affect *comprehension* also affect trust. *Communications about the intervention* should increase trust in mask use as well as comprehension of risk information, by giving people a reasonable sense of control. *Other messages*, from the media or from peers, may threaten or bolster the effectiveness of the official communications, depending on whether they agree. *Prior beliefs* also affect whether people understand how and when to use masks.

Again, the influence of emotion as an index variable was incorporated into the model. As in Figure 1, the emotions in Figure 2 include fear and anger. With regard to the variables depicted in Figure 2, these emotions are expected to affect (1) the risk of (co-)morbidity, (2) social and emotional resilience, (3) comprehension, (4) feasibility, (5) trust, (6) compliance, and (7) private stockpiling. The explanations below are based on the distinctions outlined in Table 1. As in section 2.2.1., we distinguish between the effects of fear and anger on actual versus perceived behavior (e.g., the actual feasibility of implementing a mitigation strategy versus the perception of being able to do so.)

First, as mentioned in section 2.2.1., the risk of co-morbidity may be larger with both fear and anger because negative affect reduces the immune response (Cohen & Herbert, 1986). As a result, it may make people more prone to infection with influenza. In contrast, *perceptions* of the risk of co-morbidity may differ for fearful participants and ones that feel angry. Whereas fear tends to increase perceptions of risk, anger tends to reduce them (Lerner et al., 2003).

Second, as also argued in section 2.2.1., fear and anger may have differential effects on social and emotional resilience. Because fear is related to low certainty and low perceived control, it is expected to reduce resilience. Anger should increase resilience if it leads people feel more in control over the situation.

Third, *perceived* comprehension may be lower in fearful participants, who experience low certainty, and higher in angry participants, who experience high certainty (Table 1). In contrast, actual comprehension of risk information and mitigation strategies may be threatened by both fear and anger because both emotions lead to medium attentional activity (Table 1). However, it has been suggested that emotions related to uncertainty, such as fear, should lead to deeper processing of information than emotions related to certainty, such as anger (Lerner & Tiedens, 2006; Tiedens & Linton, 2001). Possibly, fear makes people uncertain about whether they understand risk information, making them think harder about it. On the other hand, anger may give people a false sense of certainty, making them feel that they do not need to process information deeply -- when they really do.

Negative emotions may also impede the application of principles of coherent, internally and/or logically consistent judgment. One result of deeper thinking may be producing more coherent probability judgments, which are crucial to making good decisions about risks and possible mitigation strategies. People may have the general ability to make sound probability judgments. Adults' judgments of travel risks related to different destinations is sensibly related to their hypothetical decisions to travel to these destinations, even after controlling for their emotions (Fischhoff et al., 2004). Even adolescents can produce relatively sound probability judgments, when predicting significant life events such as getting a high school diploma by age 20, in terms of correlations with related behaviors, such as currently being in school (Fischhoff et al., 2000), and in terms of actual outcome rates observed by age 20 (Bruine de Bruin et al., in press, a). However, producing coherent probability judgments may be more challenging in the context of domestic threats, which are characterized by high uncertainty and negative emotions. Because the risks of domestic threats are often unknown, another challenge is gauging the predictive accuracy of related risk judgments. In those cases, risk judgments are often evaluated in terms of their coherence, or how well they follow the rules of probability theory. In the present research, we examined two coherence requirements for probability judgments. First, probability judgments of complementary events (e.g., getting sick from bird flu and not getting sick from bird flu) must add up to 100%. This requirement is known as the additivity property (see, e.g., Mandel, 2005). Second, for probability judgments to be coherent, they must conform to the conjunction rule (Tversky & Kahneman, 1983). That is, the judged probability of a conjunction of events ought to be smaller than or equal to the probability of one of the conjoint events. For example, judging that the probability of contracting bird flu *and* dying from it (a conjunction) as more likely than the probability of contracting bird flu (a constituent event) would violate the conjunction rule. The study of coherence is based on the heuristics and biases program introduced by Kahneman and Tversky (for an overview, see Kahneman, Slovic, & Tversky, 1982). The ability to produce coherent probability judgments is relevant to obtaining better real-world decision outcomes (Bruine de Bruin et al., 2007; Parker & Fischhoff, 2005). Although the need to follow the rules of probability theory may seem obvious, violations have been observed even when related (complementary and conjunction/constituent) events are judged at the same time – though more so when they are judged separately (Mandel, 2005). Project 1 investigated whether participants' levels of fear and anger account were related to the expression of coherence in judgment, and whether the coherence was influenced by the characteristics of the task—namely, whether logically related judgments were presented together or separately.

Fourth, predictions regarding feasibility are unclear. Fear, which is related to low perceived control (Table 1), is expected to decrease the feasibility of mask use. However, fear is also related to high anticipated effort (Table 1), which may be applied even when little control is seen. Hence, the actual feasibility of mask use may be increased by fear. Anger, which is related to increased perceptions of control and medium anticipated effort (Table 1), should make the implementation easier -- if angry people see enough risk to choose mask use.

Fifth, predictions regarding trust are less clear for fear than for anger. Fear, due to its relationship to low levels of personal control (Table 1), may lead people to doubt messages. However, fear may lead people to see negative events outside of anyone's responsibility – so that public officials are not blamed for the outbreak, nor seen as failing the public. Anger, on the other hand, has been shown to lower trust (Dunn & Schweitzer, 2005), possibly because it leads people to blame others (Goldberg et al., 1999; Quigley & Tedeschi, 1996) and is directly related to the perceived unfairness of procedures and outcomes affecting individuals (Dhimi et al., 2005).

Sixth, compliance with mitigation strategies should follow the predictions made above (section 2.2.1.). That is, predictions with regard to compliance are unclear for fear, due to its relationship to high anticipated effort and feelings of low personal control (Table 1). For anger, predictions are also unclear. Table 1 suggests that anger is related to medium anticipated effort and high personal control, suggesting that angry people should show better compliance. However, because anger also leads people to see less risk, angry people may not see the need to use barrier methods.

Seventh, the judged likelihood of having a sufficient private stockpile of masks should be higher for people who are more fearful, because that fear is related to feelings of low certainty and low control (Table 1). Because anger triggers high certainty and high control (Table 1), it should lead to believing it is more likely that one will have a sufficient stockpile, when faced with the risk.

2.3 Models of the risk of radiological dispersion devices

2.3.1. Overview model

Figure 3 is based on the model of radiological dispersion devices developed by Dombroski (2005), and based on a review of existing literature on radiological dispersion devices (Kelly, 2002; Levi & Kelly, 2002; National Council on Radiation Protection and Measurements, 2001), radiation exposure processes (Till & Meyer, 1983), emergency risk communications (National Council on Radiation Protection and Measurements, 2001; Lindell & Perry 1992; Weedn et al., 2004), and public behavior in emergencies (Dombroski et al., 2006; Houts et al., 1989; Janis, 1951; Tierney, 2003). Its outcome nodes, presented in blue ovals, are *morbidity and mortality*. Morbidity and mortality are affected by internal or external *exposure* to harmful radiation processes, which is affected by the *initial bomb specifications*, such as its size and content. *Physical harm from the blast*, which also depends on initial bomb specifications, directly affects morbidity and mortality.

Initial bomb specifications affect radiation exposure through its effect on *air concentration* of radioactive materials, which influences *ground concentration*, which, in turn, causes *surface water contamination*, *groundwater contamination*, *soil contamination*, and *food contamination*. Air concentration may be increased by atmospheric circumstances spreading radiation, including *temperature*, *wind speed and direction*, *atmospheric stability*, and *precipitation*. Ground concentration is predominantly affected by *geography*.

Figure 3 shows, in beige rectangular nodes, the actions that might be undertaken by public officials. *Radiation detection*, influenced by air and ground concentration, will lead to a *shelter/evacuation and decontamination policy*, possibly depending on where people live. The policy may affect people's exposure, during their travel to a safer place (whether a shelter or evacuation site), and while there, if they do not properly decontaminate. *Compliance* to that policy may also affect people's exposure to radiation, and depend on *communications about the intervention*, and whether people have observed physical harm from the blast, indicating the perceived urgency of the need to follow the recommended policy.

Emotions are also included in the overview model of the risk of radiological dispersion devices, suggesting effects on (1) compliance, and (2) morbidity and mortality. Fear and anger influence these variables in the same ways as described for Figure 1. That is, negative affect is expected to reduce immune function and make people vulnerable to infections (see Cohen & Herbert, 1996). With regard to compliance, predictions are unclear for fear as well as anger, due to the opposite forces of anticipated effort and personal control.

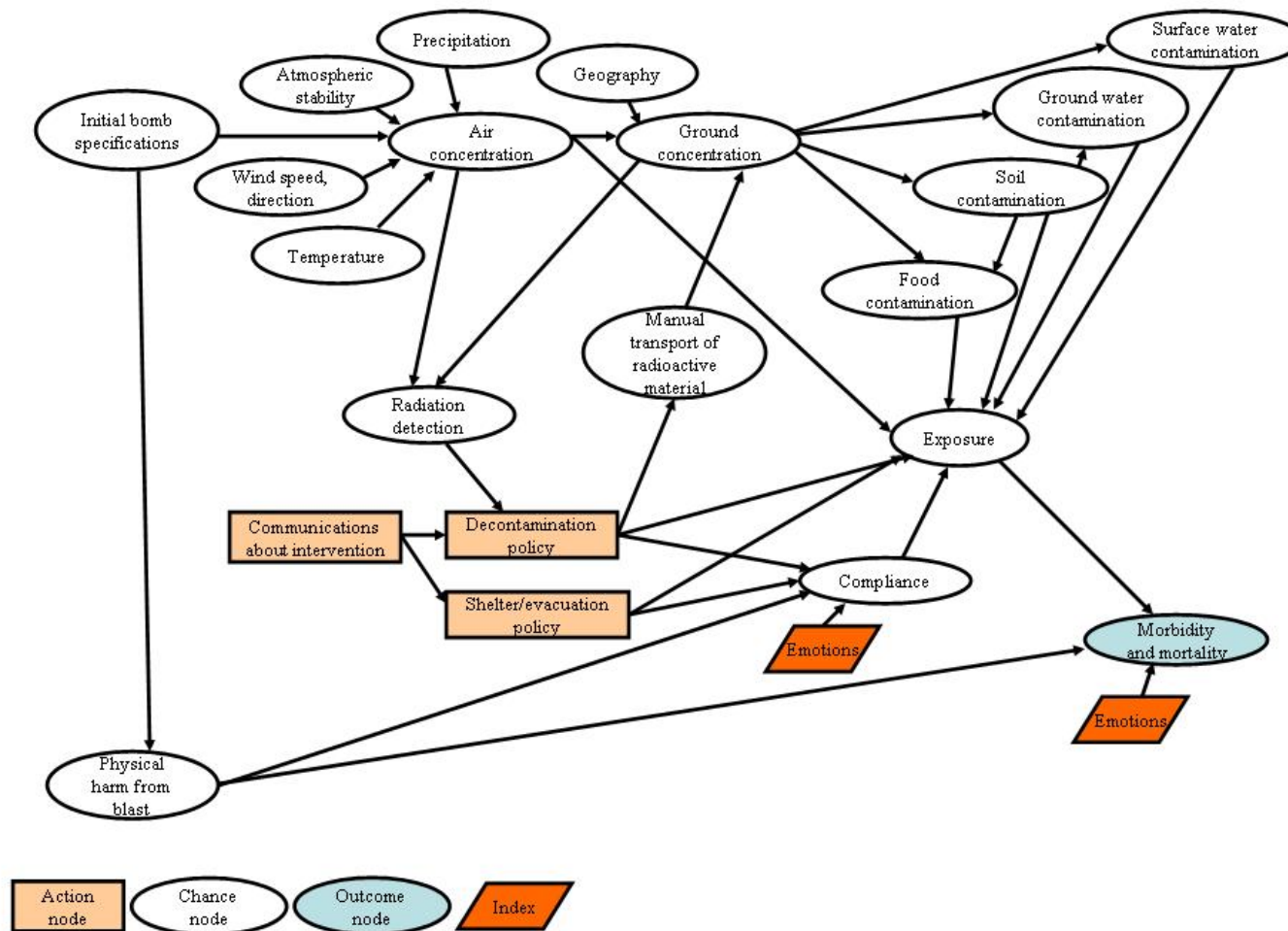


Figure 3: Overview model of the risk of radiological dispersion devices

2.3.2. Detailed models of compliance with advice to shelter at home or evacuate

Figures 4 and 5 show specific models predicting compliance with advice to shelter at home and evacuate, respectively. They are similar in structure to Figure 2, which shows the specific model for compliance to using barrier methods for mitigating influenza risk. Indeed, the three models are based on a general model of compliance, which was adapted from Fischhoff et al. (2006) for each of the specific interventions. They include the feasibility of the strategy, trust that it will work, and the availability of relevant goods. The same factors affect these variables, though their interpretation may differ by context.

Compared to the compliance model for barrier methods, Figure 4 only changes three nodes affecting *feasibility* of sheltering at home, which are presented in purple. *Location of self* affects whether people will be able to reach their home shelter in time. *Location of loved ones* may affect feasibility as well, because people may rather reach their loved ones than shelter in place without them. These factors interact with *time left to shelter*, during which loved ones and relevant goods may be gathered to make sheltering in place more feasible.

Figure 5 is slightly more altered, as shown in its purple nodes. As for sheltering, feasibility of evacuating is affected by *location of loved ones*, and *time left to evacuate*. It may be seriously threatened by *road congestion* because of increased traffic flow and people abandoning their vehicles. *Vehicle availability* also affects the feasibility of evacuating, such that people who have to rely on public transportation may be left behind.

Figures 4 and 5 include emotion variables, affecting (1) feasibility, (2) trust, (3) comprehension of risk information and mitigation strategies, (4) (co-)morbidity, (5) private stockpiling, (6) social and emotional resilience, and (7) compliance. Thus, it affects the same variables as Figure 2, the detailed model of compliance with the advice to use barrier methods to protect against the risk of pandemic influenza. Hypotheses for the effects of fear and anger on these variables are the same for the context of the risk of radiological dispersion devices presented here.

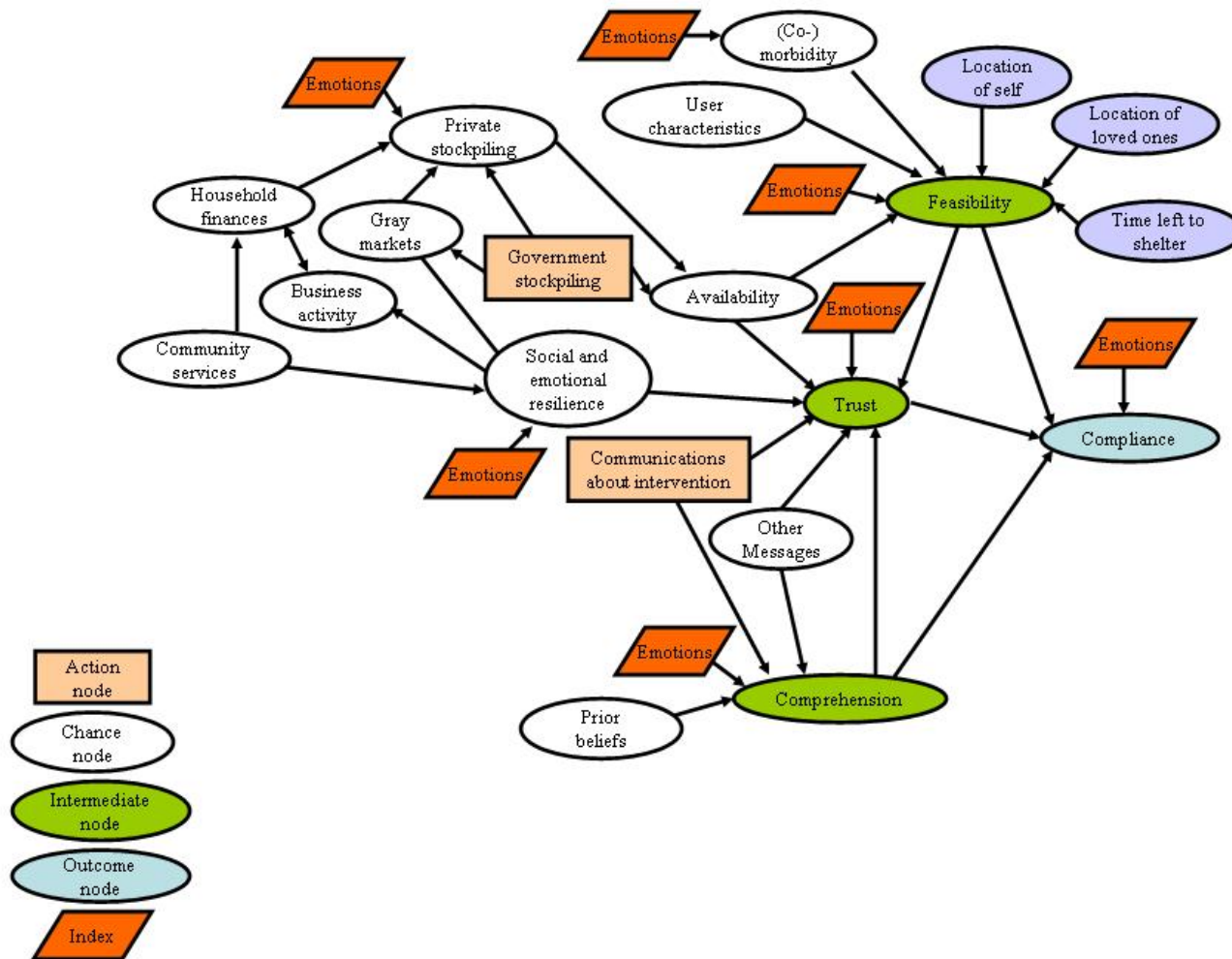


Figure 4: Model of compliance with sheltering at home

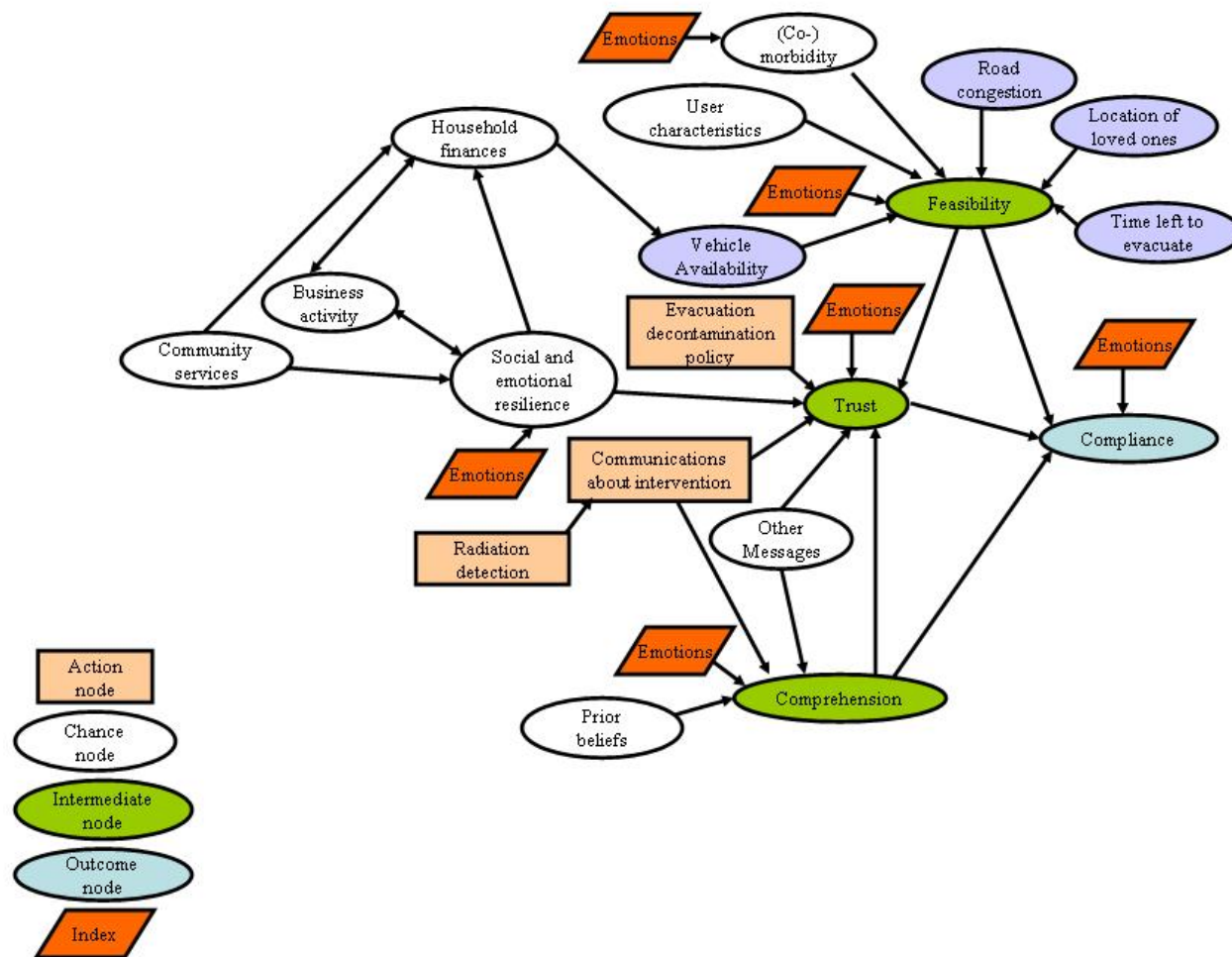


Figure 5: Model of compliance with evacuating

2.4. Survey

2.4.1. Hypotheses

Hypotheses for project 1 are based on the Appraisal-Tendency Framework (Lerner & Keltner, 2000) presented in Table 1, as explained in detail in sections 2.2.1. and 2.2.2. Because the survey will measure perceptions rather than actual behavior, the hypotheses focus on, for example, the relationship between emotions and the *perceived* feasibility of specific mitigation strategies than on the actual feasibility of implementing them. As discussed in sections 2.2.1. and 2.2.2., we have separate hypotheses pertaining to fear and anger, affecting (1) risk judgments of morbidity and mortality, (2) predictions of resilience, (3) predictions of absenteeism, (4) coherence of probability judgments, (5) perceived comprehension, (6) judged probability of having sufficient stockpiles; (7) perceived feasibility of mitigation strategies, (8) compliance with mitigation strategies, and (9) trust in risk messages about mitigation strategies.

2.4.1.1. Fear

First, we predict that judgments of the risk of co-morbidity increase with fear, due to feelings of low certainty (Table 1). Lerner et al. (2003) suggest that this is indeed the case in Americans' judgments of terror risks.

Second, as argued in section 2.2.2., we predict that fear will decrease feelings of social and emotional resilience. Because fear is related to low certainty and low perceived control, it is expected to reduce resilience.

Third, as mentioned in section 2.2.1., we predict that fear will lead workers to stay at home during a flu pandemic, due to seeing more risk and low control over mitigating it (Table 1)

Fourth, we predict that probability judgments will be more coherent as fear increases. As explained in section 2.2.2., fear is an emotion that is associated with feelings of uncertainty (Table 1), which has been found to deepen the processing of information (Lerner & Tiedens, 2006; Tiedens & Linton, 2001). As a result of receiving more thought, we expect that risk judgments should become more coherent, in terms of following the rules of probability theory. That is, coherence is achieved if probability judgments of (a) complementary events (e.g., getting sick from bird flu versus not) add up to 100%, and (b) conjunctions (e.g., getting sick from bird flu *and* dying) are judged less or equally probable than their corresponding constituent events (e.g., getting sick from bird flu). Following Mandel (2005), we will also examine whether the proportion of correct responses is higher when item pairs are presented together (versus separately), thus making their complementary or conjunction/constituent relationship more salient.

Fifth, we predict that perceived comprehension will decrease with increased fear, due to feelings of low certainty (Table 1).

Sixth, as explained in section 2.2.2., we predict that the judged probability of having a sufficient stockpile will decrease with fear.

Seventh, as explained in section 2.2.2., predictions with regard to the effect of fear on the perceived feasibility of implementing mitigation strategies are unclear. On the one hand, the association of fear with feelings of low perceived control (Table 1), may reduce the feasibility of implementing mitigation strategies. On the other hand, the association of fear with high anticipated effort (Table 1) may increase the feasibility of successfully implementing mitigation strategies.

Eighth, as explained in section 2.2.2., predictions with regard to compliance are unclear for fear, due to its relationship to high anticipated effort, which might improve compliance, and feelings of low personal control, which might decrease compliance (Table 1).

Ninth, predictions regarding the effect of fear on trust are not clear. Fear, due to its relationship to low levels of personal control, may lead people to doubt advice to use specific mitigation strategies. However, fear may also lead people to believe that nobody is responsible for negative events – so that public officials are not blamed for the threat, or seen as failing the public.

2.4.1.2. Anger

First, we predict that judgments of the risk of co-morbidity decrease with anger, due to feelings of high certainty (Table 1). Such a finding would replicate Lerner et al. (2003), who found that anger does indeed decrease judgments of risk.

Second, as argued in section 2.2.2., we predict that anger will increase social and emotional resilience. Because anger is related to high certainty and high perceived control, it is expected to increase feelings of resilience.

Third, predictions with regard to the effects of anger on absenteeism are less clear. Anger should lead to less absenteeism, because of its relationship to seeing less risk and more control over mitigating the risk (if they see it.) However, angry people may hold others responsible for the situation, and refuse to go to work out of spite.

Fourth, we predict that the coherence of probability judgments, and explained in section 2.2.2., will decrease with anger. Previous research has found that emotions that are characterized by certainty, such as anger, decrease depth of processing (Lerner & Tiedens, 2006; Tiedens & Linton, 2001), which should undermine the coherence of probability judgments.

Fifth, we predict that perceived comprehension will increase with increased anger, due to feelings of high certainty (Table 1).

Sixth, as explained in section 2.2.2., we predict that the judged probability of having a sufficient stockpile will increase with anger.

Seventh, predictions of the effect of anger on the feasibility of implementing mitigation strategies are unclear. On the one hand, anger is associated with perceptions of high control and medium anticipated effort (Table 1), which may improve feasibility. On the other hand, the high certainty experienced by angry people (Table 1) may lead to reduced perceptions of risk (Lerner et al., 2003), such that they are skeptical about the feasibility of implementing mitigation strategies.

Eighth, predictions of the effect of anger on compliance with mitigation strategies are unclear. On the one hand, anger is associated with feelings of medium anticipated effort and high personal control, which might improve compliance. On the other hand, feelings of high certainty associated with anger (Table 1) may make angry people feel that they are not ‘at risk’ (Lerner et al., 2003) or in need for using mitigation strategies.

Ninth, we predict that anger will decrease trust. Anger has already been shown to lower trust (Dunn & Schweitzer, 2005), possibly because it leads people to blame others (Goldberg et al., 1999; Quigley & Tedeschi, 1996) and is directly related to the perceived unfairness of procedures and outcomes affecting individuals (Dhimi et al., 2005).

2.4.2. Method

2.4.2.1. Participants

In total, 106 participants were recruited through community groups and newspaper ads in the Toronto area in Canada, and 104 participants recruited through community groups in the Greater Pittsburgh Metropolitan area in the United States. Both were samples of convenience. Average age was 43.3 ($SD = 14.8$), with Canadian participants being younger than American participants ($M = 42.0$ vs. $M = 49.0$), $t(154) = 2.75, p < .01$. Sixty percent of Canadians and 71% of Americans were women, showing no significant difference between these groups, $\chi^2(1) = 2.56, p > .10$. For Canadian participants, highest level of education completed was a graduate degree (8%), a college degree (50%), a high school degree (40%), and no degree (2%). Among American participants highest level of education completed was a graduate degree (10%), a college degree (27%), a high school degree (62%), and no degree (1%). Thus, Canadian participants were better educated than American participants, $\chi^2(1) = 12.24, p < .01$.

2.4.2.2. Procedure

Participants first completed a baseline state emotion measure, which is presented in Annex A. It asked participants to rate the extent to which they felt different specific emotions “today,” using a response scale ranging from 0 (verbally labeled “do not feel the emotion the slightest bit”) to 8 (verbally labeled “feel the emotion even more than ever before”). Subsequently, they completed a trait emotion measure, which is presented in Annex B. It asked participants to rate emotional statements about how they “generally” feel on a scale from 1 (verbally labeled “almost never”) to 4 (verbally labeled “almost always”). Both were adapted from Lerner et al. (2003).

Subsequently, participants received project 1 and 2 materials, the order of which was counterbalanced across participants. Project 1 materials presented a “dirty bomb” (i.e., a radiological dispersion device) scenario and a “bird flu” scenario, the order of which was counterbalanced. Annex C shows the dirty bomb scenario, which was the same for participants recruited in Canada and in the U.S. Information about distances, such as the distance from the blast, was presented in terms of kilometers as well as miles. Annex D shows the bird flu scenario as it was presented to Canadian participants. American participants received the same information, except that estimates of the number of people sick and dying in terms were relative to the American population. These estimates were taken from an expert panel on pandemic influenza, conducted by Bruine de Bruin et al. (2006). After explaining the threat to the participant’s home town¹, each scenario recommended a mitigation strategy, namely using N-95 surgical masks to protect against bird flu, and seeking shelter to protect against dirty bombs.

After reading each scenario, participants answered questions about it. Annex E shows the questions that were asked about the dirty bomb scenario, and Annex F shows the questions that were asked about the bird flu scenario. Each question in Annex E and Annex F are labeled with the construct they were intended to measure. Participants were not presented with these labels.

The first two questions about each scenario measured perceived comprehension, by asking participant to rate how well they understood the information, on a scale ranging from 1 (verbally labeled “not at all”) to 7 (verbally labeled “very much”), and how hard or easy it would be to remember the information when facing the risk, on a scale ranging from 1 (verbally labeled “very

¹ Eight Canadian participants received a version of the bird flu scenario that provided Canadian as well as US statistics of morbidity and mortality, while the remainder received only Canadian statistics. Because their responses appeared unaffected, the eight Canadians were included in the reported analyses.

hard”) to 7 (verbally labeled “very easy”). The next two questions measured trust, rated on a scale ranging from 1 (verbally labeled “not at all”) to 7 (verbally labeled “very much”). Subsequent questions used a scale from 1 (labeled “very hard”) to 7 (labeled “very easy”) and measured feasibility of the proposed mitigation strategy (e.g., how hard or easy would it be for you to wear an N-95 surgical mask when taking care of loved ones who are sick?) and resilience, including psychological and physical coping (e.g., how hard or easy would it be for you to cope psychologically if you were infected with bird flu). Subsequent questions used a scale ranging from 0% (verbally labeled “no chance”) to 100% (verbally labeled “certainty”). They measured perceived morbidity and mortality risk, (e.g., what is the chance that you would get sick from bird flu and die from it?), compliance with the mitigation strategy (e.g., what is the chance that you would use a new N-95 mask every time you wore a mask?), and the probability of having a sufficient stockpile (e.g., what is the chance that you would have enough N-95 surgical masks for your own personal use by the time there is human-to-human transmission of bird flu in this country?). For the bird flu scenario, a set of questions also asked about absenteeism (e.g., what is the chance that you would continue to go to work, even if you did not have enough N-95 surgical masks for your own personal use?).

The latter section of probability questions also allowed us to evaluate whether participants’ probability judgments showed coherence, in the sense of following the rules of probability theory. Following each scenario, four pairs of questions presented complementary events (e.g., buying masks versus not buying masks), for which probabilities should add up to approximately 1, and four pairs of questions presented a conjunction (e.g., getting sick with bird flu and dying), for which the probability should be smaller than or equal to the probability of the corresponding constituent event (e.g., getting sick with bird flu). Annex E shows that each probability question about the dirty bomb scenario, including those referring to the risk of morbidity and mortality and those referring to the probability of complying to risk messages, was also a member of a complementary or a conjunction/constituent pair.² Annex F shows that the same is true for probability questions about the bird flu scenario. Half of each set of pairs was presented together, while the other half was separated by at least two other items, to vary the transparency of the relationship between item pairs (Mandel, 2005).

After completing the questions about the dirty bomb scenario, participants rated how they felt, on the state emotion measure that was also given at baseline. However, rather than asking participants how they felt “today,” questions asked how they felt “when they read the information about the dirty bomb.” Similarly, the state emotion measure presented after the bird flu scenario asked participants to rate how they felt “when they read the information about the bird flu.”

After completing project 1 and project 2 materials, participants answered questions about their demographics, as shown in Annex I. Participants in Canada received \$30 in Canadian dollars, and participants in the U.S. received \$30 in American dollars for their participation.

² Although questions 13 and 14 do not constitute a conjunction/constituent pair, the probability of the event in question 13 occurring is smaller than or equal to the probability of the event in question 14 occurring – as is the case with conjunction/constituent pairs.

2.4.3. Results

2.4.3.1. Emotions

Trait emotions showed good internal consistency, as reflected by Cronbach's alpha. A Cronbach's alpha that is larger than .6 suggests that the items may represent a shared underlying construct, as reflected in the mean response across items. It was .82 across the four items measuring feelings of fear, and .81 across the four items measuring feelings of anger. Reported state emotions showed good internal consistency at baseline, with Cronbach's alpha being .86 across the twelve items measuring fear and .95 across the ten items measuring anger. Similar levels of internal consistency was found for state emotions reported after reading the bird flu scenario ($\alpha = .96$ for fear; $\alpha = .97$ for anger), and after reading the dirty bomb scenario ($\alpha = .96$ for fear; $\alpha = .97$ for anger). A summary measure was computed for each state and trait emotion, by averaging across related responses.

As seen in Table 2, these summary measures of the emotion variables generally showed significant correlations of moderate magnitude with each other. The strongest correlations were observed between state fear and state anger, when reported at the same time. That is, fear and anger were strongly correlated at baseline, after reading the dirty bomb message, and after reading the bird flu message. Strong correlations were also observed between emotional responses to the dirty bomb and bird flu scenario, suggesting that participants reacted similarly to each.

Table 2: Correlations between emotion variables.

Emotion Variables	Fear				Anger			
	About dirty bomb	About bird flu	Baseline	Trait	About dirty bomb	About bird flu	Baseline	Trait
Dirty bomb fear	—	.80***	.38***	.28***	.81***	.67***	.26***	.18**
Bird flu fear		—	.43***	.32***	.69***	.75***	.30***	.20**
Baseline fear			—	.42***	.29***	.42***	.72***	.25***
Trait fear				—	.24**	.33***	.42***	.38***
Dirty bomb anger					—	.77***	.31***	.27***
Bird flu anger						—	.43***	.29***
Baseline anger							—	.44***
Trait anger								—

Note: *** $p < .001$; ** $p < .01$.

To examine whether the presented scenarios did indeed change reported emotions, we conducted four separate repeated measures analysis comparing baseline emotions with those reported after reading each scenario, by country of residence (Canada versus U.S.) while controlling for baseline emotions. Figure 6 shows that, compared to baseline, reading the dirty bomb scenario caused an increase in reported fear, $F(1, 204) = 6.58, p < .05$, while the bird flu scenario showed a marginally significant increase, $F(1, 198) = 3.24, p = .07$. Similarly, anger increased after participants read the dirty bomb scenario, $F(1, 204) = 6.34, p < .05$, and the bird flu scenario $F(1, 198) = 4.05, p < .05$, compared to baseline.

Participants recruited in Canada versus the U.S. showed no significant differences in terms of fear ($p > .10$). However, a main effect of country of residence revealed that Canadians were less angry than U.S. participants, $F(1, 204) = 4.28, p < .05$ in response to the dirty bomb scenario, and $F(1, 198) = 4.25, p < .05$ in response to the bird flu scenario. We found no significant interaction between country of residence and the degree to which emotions *changed* after reading each scenario ($p > .10$). Because we focus on these *changes* in emotions, the reported analyses are collapsed across Canadians and U.S. participants.

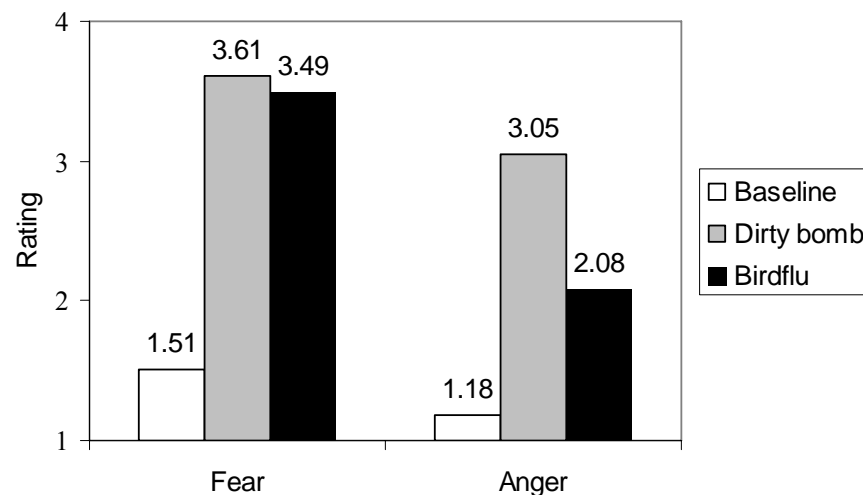


Figure 6: Reports of fear and anger

2.4.3.2. Perceived morbidity and mortality risk

As seen in Annex E and Annex F, one question about each scenario asked about the probability of not getting sick. Responses to these questions were reverse-coded. Responses to perceived morbidity and mortality risk showed good internal consistency, as reflected by Cronbach's alpha ($\alpha = .71$ for the bird flu scenario; $\alpha = .79$ for the dirty bomb scenario). Mean perceived morbidity and mortality risk was 41.6% ($SD = 18.1$) for the dirty bomb scenario, and 47.0% ($SD = 17.5$) for the bird flu scenario.

Pearson correlations of judged risk with emotion variables are shown in Table 3. Participants who reported more fear about the dirty bomb scenario saw more risk in that scenario, as did participants who reported more fear about the bird flu scenario. Anger reported after reading about each threat also increased judgments of the related risks.

Table 4 shows the results of linear regressions predicting judged risk for each scenario, using fear experienced after reading about that scenario, while controlling for baseline and trait fear. We present standardized beta weights, which vary between -1 and +1 to indicate the degree to which each predictor variable (e.g., fear about the dirty bomb scenario) is correlated to the criterion variable (e.g., judged risks related to the dirty bomb scenario), while statistically controlling for the effect of other predictor variables (e.g., baseline fear and trait fear). Model 1 suggests that fear about the dirty bomb scenario increased judged risks for that scenario, even after controlling for baseline and trait fear. Similarly, model 3 suggests that fear about the bird flu scenario increased judged risks for that scenario, when controlling for baseline and trait fear.

Table 4 shows the results of similar regressions predicting judged risks, using anger variables as the predictors. Anger reported after reading each scenario increased risk judgments for these scenarios.

Table 5 shows the results of linear regressions predicting judged risk for each scenario, using all emotion variables. Thus, it shows whether changes in fear and changes in anger are independently related to judged risk, while also controlling for trait emotions. For both the dirty bomb and the bird flu scenario, reported fear about the scenario increased the judged risk of morbidity and mortality. A Strube test (1985) for combining dependent analyses showed that across the two scenarios, this relationship was significant in the direction predicted in section 2.4.1.1. ($z = 3.57, p < .001$). Our prediction for anger, stated in section 2.4.1.2., was not confirmed ($p > .10$). That is, anger reported after reading these scenarios did not significantly predict judged risks, suggesting that fear explained the significant relationships shown in Table 4.

2.4.3.3. Resilience

Cronbach's alpha (α), which reflects the internal consistency of a set of items, was .75 across the two items referring to the dirty bomb scenario and .82 across the three items referring to the bird flu scenario. The mean response was 3.77 ($SD = 1.55$) for the dirty bomb scenario, and 2.98 ($SD = 1.40$) for the bird flu scenario.

As seen in Table 3, both fear and anger about each scenario reduced participants' ratings of their resilience. Table 4 shows that these relationships remained significant, after controlling for the specific baseline and trait emotion. Table 5 shows that, when controlling for other emotion variables, the fear reported about the dirty bomb scenario still significantly decreased resilience, but anger did not. Fear and anger reported for the bird flu scenario were no longer significantly related to resilience, after controlling for all other emotion variables. A Strube test (1985) showed that, across the two scenarios, fear was significantly related with resilience ($z = 2.83, p < .01$), while anger was not ($p > .10$). Thus, these analyses support the prediction for fear explained in section 2.4.1.1., but not the one for anger, which was explained in section 2.4.1.2.

2.4.3.4. Absenteeism

As seen in Annex F, two questions about the bird flu scenario asked participants to judge the probability that they would (not) continue to go to work, with the one about continuing to go to work being reverse-coded. Because Cronbach's alpha across these two bird flu-related items was relatively low (.57), caution is warranted when interpreting related results. The mean judged probability for being absent from work was 61.8% ($SD = 24.6$).

Table 3 shows that fear about the bird flu scenario increased predicted absenteeism, whereas anger about the bird flu scenario did not show a significant relationship with predicted absenteeism. Table 4 shows that fear about the bird flu scenario increased predicted absenteeism even after controlling for baseline and trait fear. As shown in Table 5, this relationship also remained significant after controlling for baseline and trait fear. Thus, these analyses support our prediction for the effect of fear on predicted absenteeism, explained in section 2.4.1.1. As stated in section 2.4.1.2., we had no clear prediction for the effect of anger on predicted absenteeism.

Table 3. Correlations between emotions and cognitive variables.

Cognitive variables	Dirty bomb						Bird flu					
	Fear			Anger			Fear			Anger		
	About dirty bomb	Baseline	Trait	About dirty bomb	Baseline	Trait	About bird flu	Baseline	Trait	About bird flu	Baseline	Trait
Risk	.35***	.27***	.27***	.22**	.15*	.02	.35***	.08	.18**	.28***	.06	.02
Resilience	-.40***	-.20***	-.31***	-.29***	-.09	-.05	-.24**	-.20**	-.21**	-.17*	-.07	.04
Absenteeism	-	-	-	-	-	-	.15*	-.04	-.04	.07	-.08	.00
Coherence	-.12*	-.01	-.13*	-.10	-.02	.03	-.23**	-.08	-.08	-.17*	-.09	.03
Comprehension	.01	.05	-.20***	.04	.04	.04	-.06	-.09	-.13*	-.12*	-.08	.02
Stockpile	-.20**	-.11	-.29***	-.16*	-.01	.10	.14*	-.03	.13*	.18*	-.03	.16*
Feasibility	-.18*	-.13*	-.25***	.09	-.08	.03	.08	-.06	.01	.08	-.05	.13*
Compliance	-.18*	-.16*	-.23***	-.25***	-.25**	-.18*	.25***	-.04	.04	.18**	-.06	-.01
Trust	-.14*	-.15*	-.29***	-.13*	-.15*	-.19***	-.09	-.18*	-.28***	-.15*	-.20**	-.18**

Note: *** $p < .001$; ** $p < .01$; * $p < .05$; + $p < .10$

Table 4. Predicting cognitive variables from fear or anger variables.

Cognitive variables	Dirty bomb						Bird flu					
	Model 1: Fear			Model 2: Anger			Model 3: Fear			Model 4: Anger		
	About dirty bomb	Baseline	Trait	About dirty bomb	Baseline	Trait	About bird flu	Baseline	Trait	About bird flu	Baseline	Trait
Risk	.26***	.11	.16*	.20**	.14*	-.09	.38***	-.14*	.11	.31***	-.09	.01
Resilience	-.35***	.03	-.23***	-.30***	-.02	.04	-.18*	-.05	-.13*	-.19*	-.02	.09
Absenteeism	-	-	-	-	-	-	.21**	-.10	-.07	.12	-.16*	.04
Coherence	-.12	.08	-.12	-.11	-.02	.07	-.25**	.06	-.04	-.18*	-.03	.09
Comprehension	.03	.16*	-.27***	.03	.02	.02	-.02	-.03	-.10	-.12	-.04	.06
Stockpile	-.14*	.06	-.28***	-.16*	-.01	-.10	.17*	-.16*	.12	.23**	-.26**	.24**
Feasibility	-.12	.01	-.23**	-.08	-.10	.09	.11	-.10	.04	.10	-.17*	.18*
Compliance	-.11	-.05	-.18*	-.18*	-.17*	-.05	.32***	-.16*	.01	.24**	-.15*	.02
Trust	-.07	.00	-.27***	-.07	-.07	-.14*	.03	-.08	-.25**	-.07	-.12	-.12

Note: *** $p < .001$; ** $p < .01$; * $p < .05$; + $p < .10$

Table 5. Predicting cognitive variables from fear *and* anger variables.

Cognitive variables	Model 1: Dirty bomb						Model 2: Bird flu					
	Fear			Anger			Fear			Anger		
	About dirty bomb	Baseline	Trait	About dirty bomb	Baseline	Trait	About bird flu	Baseline	Trait	About bird flu	Baseline	Trait
Risk	.35**	.14	.20**	-.11	-.04	-.10	.33**	-.14	.11	.07	-.01	-.03
Resilience	-.38**	-.05	-.28***	.04	.11	.08	-.17	-.14	-.19*	-.01	.12	.12
Absenteeism	-	-	-	-	-	-	.23*	-.03	-.07	-.04	-.12	.06
Coherence	-.11	.09	-.15+	-.01	-.04	.11	-.25*	.12	-.06	.00	-.10	.11
Comprehension	-.04	.15	-.30***	.08	.00	.10	.09	-.03	.12	-.17	.01	.09
Stockpile	-.07	.03	-.27***	-.08	.05	-.04	.01	-.04	.07	.21*	-.25*	.22**
Feasibility	-.22+	.01	-.27**	.12	-.02	.15+	.04	-.04	.00	.08	-.14	.17*
Compliance	.07	.08	-.14	-.24*	-.19+	-.01	.28*	-.12	.01	.04	-.07	.01
Trust	-.05	.00	-.24**	-.01	.00	-.09	.09	-.04	-.21*	-.10	-.04	-.08

Note: *** $p < .001$; ** $p < .01$; * $p < .05$; + $p < .10$

2.4.3.5. Coherence of probability judgments

As explained in section 2.2.2., probability responses are coherent if judged probabilities of (a) complementary events add up to 100%, and (b) conjunctions are smaller than or equal to the judged probabilities of corresponding constituent events. Annex E shows four item pairs asking participants to judge the probability of complementary events, and four item pairs asking participants to judge the probability of the relevant conjunction/constituent. Annex F shows four complementary pairs and four conjunction/constituent pairs in probability questions asking about the bird flu scenario. Each item pair was scored as correct if it followed the rule it was intended to measure, and a 0 if it did not.

Although Cronbach's alpha between accuracy scores on item pairs was low (.44 for the dirty bomb scenario; .29 for the bird flu scenario), we computed the percent of coherently judged item pairs. The reported analyses should be interpreted with caution. The proportion of correct responses across related item pairs was .55 ($SD = 21$) for the dirty bomb scenario and .52 ($SD = 20$) for the bird flu scenario.³

As shown in Table 3, there was a marginally significant negative correlation between coherence and fear about the dirty bomb scenario, and a significantly negative correlation with fear about the bird flu scenario. For anger, coherence did not significantly correlate with anger about the dirty bomb scenario, but there was a significant negative correlation between coherence and anger about the bird flu scenario. Table 4 shows that, after controlling for related baseline and trait emotions, only fear and anger about the bird flu scenario significantly predicted coherence. Finally, Table 5 shows that, after controlling for all emotion variables, only fear about bird flu significantly predicted coherence, such that participants who reported more fear predicted less coherence. A Strube test (1985) combining results across the two scenarios found a marginally significant decrease of coherence due to increased fear ($z = 1.93, p = .05$), but not due to changes in anger ($p > .10$). Given that we had predicted that depth of processing would be better, not worse, with fear, we conclude that our predictions of the effect of specific emotions on the coherence of probability judgments, as posited in sections 2.4.1.1. and 2.4.1.2., were not supported.

Following Mandel (2005), we also examined whether coherence scores were affected by whether items were presented together or separately, thus varying the transparency of the relationship between items. Specifically, we conducted a 2 by 2 by 2 repeated-measures multivariate analysis of variance (MANOVA), examining the effect of presentation (together vs. separately), type of item pair (complementary vs. conjunction/constituent), and scenario (dirty bomb vs. bird flu). The descriptive statistics are shown in Figure 7. Participants scored better on item pairs that were presented together than on those presented separately, $F(1, 185) = 7.37, p < .01$, on conjunction/constituent item pairs than on complementary item pairs, $F(1, 185) = 174.54, p < .001$, and on those related to the dirty bomb scenario than on those related to the bird flu scenario, $F(1, 185) = 4.50, p < .05$. There was a significant interaction between type of item pair (complementary versus conjunction/constituent) and presentation (together versus separate), $F(1, 185) = 64.03, p < .001$, such that complementary items benefited more from being presented together, $F(1, 189) = 66.73, p < .001$, and conjunction/constituent items from being presented separately, $F(1, 192) = 53.64, p < .001$.

³ Because there were no interactions of fear or anger about a scenario with type of item pair (complementarity versus conjunction/constituent) or how it was presented (together versus separately), analyses were collapsed across these within-subjects conditions.

We also found a marginally significant three-way interaction between type of item pair (complementary versus conjunction/constituent), presentation (together versus separate), and scenario (dirty bomb versus bird flu), $F(1, 185) = 3.68, p = .06$, depicted in Figure 7, with the interaction between item pair and presentation being somewhat stronger for dirty bomb items than for bird flu items. In summary, the findings replicated Mandel (2005) but with some qualifications. It appears that while highlighting the relationship between judgment queries helps people arrive at additive probability judgments, highlighting the relationship between events that have a conjunction/constituent relationship actually impedes the coherence of judgment through an increase in the proportion of participants who violated the *conjunction rule*—namely, the normative requirement that the probability assigned to a conjunction of events be no greater than that assigned to one of the constituent events..

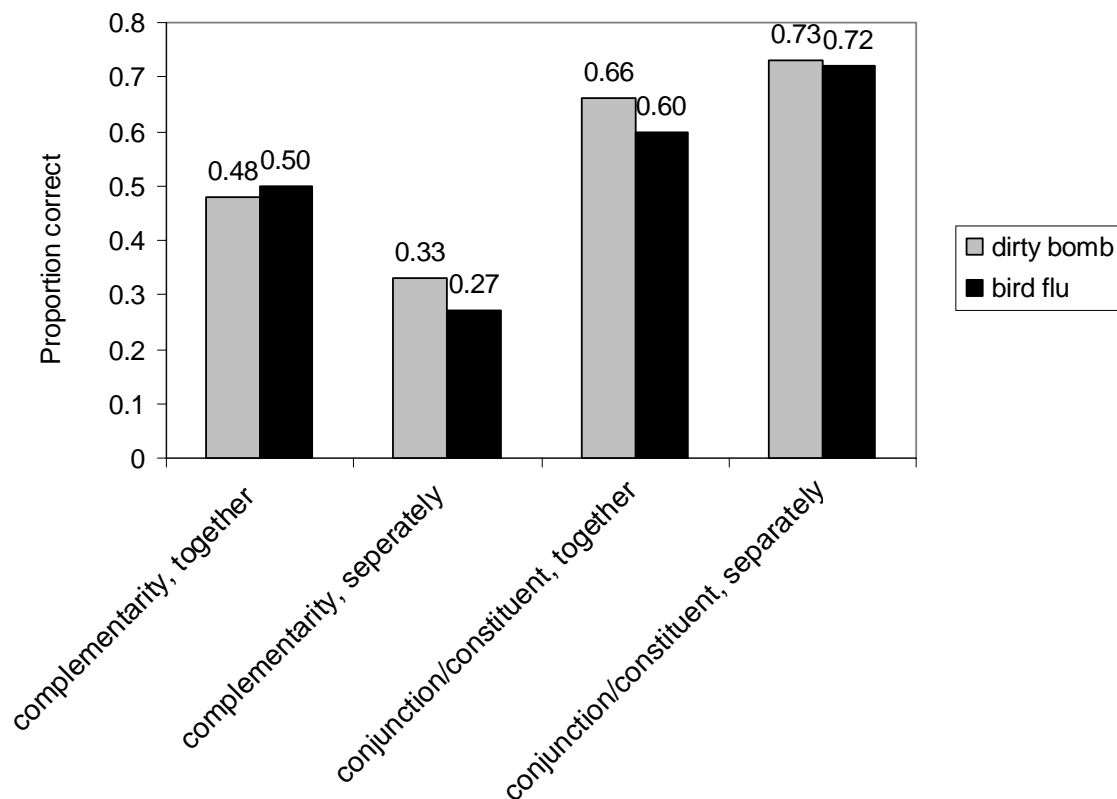


Figure 7: Proportion of correct coherence pairs

2.4.3.6. Perceived comprehension

The two self-ratings of perceived comprehension showed good internal consistency ($\alpha = .63$ for the dirty bomb scenario; $\alpha = .72$ for the bird flu scenario). The mean across these ratings was 5.78 ($SD = 1.01$) for the dirty bomb scenario and 5.73 ($SD = 1.13$) for the bird flu scenario.

Pearson correlations between perceived comprehension of the dirty bomb and bird flu scenarios with emotion variables are shown in the first row of Table 3. There was no significant correlation between perceived comprehension of that scenario and fear or anger reported after reading each scenario. These relationships remained non-significant after controlling for related baseline and trait emotions (Table 4), and when controlling for all other emotion variables (Table 5). A Strube test (1985) combining the latter results across the two scenarios showed no significant relationship of fear or anger with perceived comprehension ($p > .10$). Thus, our predictions with regard to the effect of fear and anger on perceived comprehension, as explained in sections 2.4.1.1. and 2.4.1.2., were not confirmed.

2.4.3.7. Judged probability of having a sufficient stockpile

Cronbach's alpha across the four items measuring the judged probability of having a sufficient stockpile to shelter in place during a dirty bomb attack was .71 across the four items. For the bird flu scenario, it was .67 across the two items asking for the judged probability of having sufficient N-95 surgical masks. The judged probability was 60.8% ($SD = 22.1$) for the dirty bomb scenario and 43.7% ($SD = 24.3$) for the bird flu scenario.

As seen in Table 3, participants who reported more fear and those who reported more anger in response to the dirty bomb scenario estimated lower probabilities of having a sufficient stockpile in their place of shelter. However, the opposite pattern is observed for the bird flu scenario. A marginally significant correlation between reported fear and probabilities of having a sufficient stockpile of N-95 surgical masks suggested that participants who reported more fear estimated higher probabilities of having a sufficient stockpile. That probability significantly increased with reported anger.

Table 4 also shows opposite patterns for both scenarios. After controlling for baseline and trait fear, fear about the dirty bomb scenario showed a marginally significant negative relationship with the judged probability of having a sufficient stockpile, and fear about the bird flu scenario showed a significant positive one. After controlling for baseline and trait anger, anger about the dirty bomb scenario showed a significant negative and anger about the bird flu a significant positive relationship with the judged probability of having a sufficient stockpile.

After controlling for all other emotion variables, only anger about the bird flu scenario predicted the judged probability of having a sufficient stockpile (Table 5). Combined across the two scenarios, there was no significant relationship of this variable with scenario-induced fear or anger ($p > .10$).

2.4.3.8. Feasibility

Cronbach's alpha across the two items measuring perceived feasibility was .73 for the dirty bomb scenario and .86 for the bird flu scenario. Mean reported feasibility was 5.05 ($SD = 1.53$) for the dirty bomb scenario and 4.33 ($SD = 1.89$) for the bird flu scenario.

As seen in Table 3, fear experienced about the dirty bomb scenario was related to lower ratings of the feasibility of mitigation strategies. Fear experienced about the bird flu scenario was not related to perceived feasibility. Anger experienced about each scenario was also unrelated to the perceived feasibility of mitigation strategies.

After controlling for baseline and trait fear, fear experienced after each scenario did not predict perceived feasibility (Table 4). Similarly, after controlling for baseline and trait anger, anger about each scenario was unrelated to perceived feasibility.

Table 5 shows that, after controlling for all other emotion variables, neither fear nor anger about the dirty bomb scenario predicted perceived feasibility of mitigation strategies for that scenario. Fear about the dirty bomb scenario predicted a marginally significant increase in perceived feasibility, whereas anger showed no significant relationship. A Strube test (1985) combining results across the two scenarios found no significant relationship of feasibility with fear or anger ($p > .10$). We had no clear predictions for the effects of fear and anger on perceived feasibility, as explained in sections 2.4.1.1. and 2.4.1.2.

2.4.3.9. Compliance

Annex E shows that seven questions asked participants to indicate the probability that they would comply with the risk message about the dirty bomb as presented in Annex C, and three about the probability that they would not comply. Similarly, Annex F shows that six questions asked participants about the probability that they would comply with the risk message about the bird flu as presented in Annex D, and two about the probability of not complying. Responses referring to non-compliance were reverse-coded.

The ratings of compliance showed good internal consistency ($\alpha = .75$ for the six dirty bomb items; $\alpha = .81$ for the six bird flu items). Mean compliance was 64.7% ($SD = 20.5$) for the dirty bomb scenario and 63.0% ($SD = 21.6$) for the bird flu scenario.

Table 3 shows that reported fear about the dirty bomb scenario was related to significantly lower ratings of compliance with mitigation strategies, and reported fear about the bird flu scenario with significantly higher ratings of compliance with mitigation strategies. Anger about the dirty bomb scenario was related to lower compliance for the dirty bomb scenario, and significantly higher compliance for the bird flu scenario.

Table 4 shows that, after controlling for baseline and trait fear, only fear about the bird flu scenario still significantly predicted increased compliance. After controlling for baseline and trait anger, anger about the dirty bomb scenario still predicted significantly less compliance, whereas anger about the bird flu scenario predicted significantly more compliance.

Table 5 shows that, after controlling for other emotion variables, fear did not significantly predict compliance with strategies to mitigate dirty bomb risk, and anger predicted a significant negative decrease. For the bird flu scenario, fear predicted a significant increase in compliance, while anger did not have a significant effect. A Strube test (1985) combining these results across the two scenarios found that compliance significantly increased with fear ($z = 2.12, p < .05$). There was no significant relationship with anger ($p > .10$). We had no clear predictions for the effect of fear and anger on compliance, as explained in sections 2.4.1.1. and 2.4.1.2.

2.4.3.10. Trust

Good internal consistency was found for the two items referring to the bird flu scenario ($\alpha = .75$) and for the two items referring to the dirty bomb scenario ($\alpha = .90$). Mean trust was 4.57 ($SD = 1.49$) for the dirty bomb scenario and 3.94 ($SD = 1.45$) for the bird flu scenario.

As seen in Table 3, fear reported after the dirty bomb scenario was significantly related to lower trust, with anger reported after this scenario showing a similar, marginally significant, relationship. For the bird flu scenario, only reported anger showed a significant correlation, with more angry participants showing less trust.

After controlling for the related trait and baseline emotion (Table 4), and for all other emotion variables (Table 5), neither fear nor anger about each scenario predicted trust for that scenario. A Strube test (1985) combining results across the two scenarios for the latter analyses found that neither fear nor anger predicted trust ($p > .10$). We had no clear predictions for the effect of fear and anger on trust, as explained in sections 2.4.1.1. and 2.4.1.2.

2.4.4. Discussion

In project 1, we examined whether threat scenarios changed participants' emotional states, and whether changes in experienced fear and anger had independent relationships with different responses to these threat scenarios, even after controlling for trait emotions. Our conclusions are based on Strube tests (1985), a statistical measure that combines the results of two dependent analyses to determine whether the overall effect is significant. Here, we used it to combine results across tests conducted on responses to the scenario about bird flu, and the scenario about a dirty bomb threat. Both scenarios described the risk and recommended mitigation strategies. They were found to increase feelings of fear and anger, compared to baseline reports, and after controlling for trait emotions.

In the following sections, we summarize the effects of the specific emotions of fear and anger on people's responses to domestic threats. We limit our discussion to effects that remained significant after controlling for baseline, trait, and the other specific emotion (i.e., anger when examining of fear, and fear when examining effects of anger). Such statistical controls ensure that significant effects of each specific emotion are due to that specific emotion as experienced after reading about the threat, and not due to the emotional state people were in before reading the scenarios, their stable emotional traits, or the other specific emotion. Such controls are important because all emotion variables presented here (baseline emotions, trait emotions, and fear and anger as experienced after reading about the threats) showed strong relationships to each other.

After recognizing limitations of the presented work in section 2.4.4.4., we discuss the implications of this research for the development of risk messages about domestic threats in section 2.4.4.6.

2.4.4.1. Effects of fear

Both threat scenarios, about the dirty bomb and about the bird flu, increased fear compared to baseline. We found that the fear experienced as a result of these threat scenarios affected several cognitive responses, independent of anger, baseline emotions, and trait emotions.

First, fear about the threat scenarios was related to seeing more risk of morbidity and mortality, supporting the corresponding prediction stated in section 2.4.1.1. As seen in Table 1, the Appraisal-Tendency Framework (Lerner & Keltner, 2000) associates fear with feelings of low certainty, which should lead to feeling more ‘at risk.’ The results also replicate the work of Lerner et al. (2003), who found that the fear Americans experienced after the 9/11 terror attacks led them to see more terror risk.

As predicted, fearful participants reported feeling less resilient, while giving higher probabilities for staying home during a flu pandemic. These findings follow the Appraisal Tendency Framework (Lerner & Keltner, 2000), which associates fear with feelings of low certainty and low perceived control, which, in turn, should reduce resilience and increase absenteeism. Both of these responses can contribute to the disruption of a society already suffering from the consequences of a domestic threat.

Although we had no clear prediction for the relationship between fear and compliance with recommended mitigation strategies, we found that fear was related to judging higher probabilities of such compliance. This finding may be explained by appraisals of high anticipated effort associated with fear (Lerner & Keltner, 2000). However, fear is also associated with feelings of low personal control, which could lead to seeing more barriers to good compliance. Possibly, the risk messages provided with our threat scenarios helped fearful participants to increase perceived control by clearly explaining specific mitigation strategies, including how to shelter at home during a dirty bomb attack and how to use masks during a flu pandemic.

We found no significant relationship between fear and perceived feasibility of mitigation strategies, for which we had no specific predictions (as seen in section 2.4.1.1.). The Appraisal Tendency Framework suggested contradictory predictions, which may have cancelled each other out. On the one hand, the association of fear with feelings of low perceived control may reduce the feasibility of implementing mitigation strategies. On the other hand, the association of fear with high anticipated effort may increase the feasibility of successfully implementing mitigation strategies.

Similarly, contradictory appraisals related to fear led us to have no clear prediction for the relationship between fear and trust. Low levels of personal control may lead people to doubt advice to use specific mitigation strategies, while at the same time trust may be retained because the public officials who send the messages are not seen as responsible for the threat or failing the public. However, fear may also lead people to believe that nobody can control negative events – so that public officials are not blamed for the outbreak, nor seen as failing the public. Perhaps as a result of these contradictory appraisals, we found no significant relationship between feelings of fear and reported trust.

Unlike what we predicted, we found no significant relationship between fear and perceived comprehension of risk messages. We had predicted that fear would undermine perceptions of comprehension, due to feelings of low certainty. However, because fear leads people to process information more thoroughly (Lerner & Tiedens, 2006; Tiedens & Linton, 2001), any initial uncertainty about understanding the information may have been removed.

Unlike what we predicted, we also found no significant relationship between fear and the judged likelihood of having a sufficient stockpile of necessary goods, when faced with a risk. We had predicted that fear would reduce those judgments, due to appraisals of low certainty and low control. Instead, concerns about stockpiling affected respondents independent of their reported emotions. On average, they believed that there was a 40% chance that they would not have a sufficient stockpile of food or essential goods to shelter in place during a dirty bomb attack, and a 60% chance that they would not have a sufficient stockpile of N-95 surgical masks in case of an outbreak of pandemic flu.

We also examined the effect of fear on the coherence of probability responses, reflecting whether they follow the rules of probability theory. To examine coherence, we measured whether the judged probability of (a) complementary events (e.g., buying masks versus not) add up to 100%, and (b) conjunction events (e.g., getting sick from bird flu and dying) are smaller than or equal to risk judgments of constituent events (e.g., getting sick from bird flu). A marginally significant result suggested that probability responses were less coherent when participants reported more fear. The results are not in the predicted direction, as stated in section 2.2.1. Fear has been found to deepen the processing of information (Lerner & Tiedens, 2006; Tiedens & Linton, 2001). Such deeper thinking should also benefit the coherence of risk judgments, but it did the opposite.

Our result may be different because of the particular topic of our study. Unlike the stimuli presented in previous research, we examined the coherence of probability judgments of domestic threats, which may have triggered stronger negative emotions than the events that are typically studied in lab studies of emotions, possibly making thinking about them too aversive. If so, the results that have been found in lab studies of the effect of emotions on the processing of information may not apply to the domain of domestic threats and other extremely aversive events. We recommend that follow-up research follows Lerner et al. (2003), who surveyed a large representative sample of Americans to study the effect of the fear and anger they experienced after the tragic events of 9/11 on judged risks about terrorism.

Unfortunately, domestic threats are a fact of life. The continued occurrence of natural disasters and terror threats provide an opportunity to conduct studies to understand citizens' emotional and cognitive responses, which, in turn, can help officials to prepare behaviourally realistic risk messages to future domestic threats. Section 2.4.4.6. provides a more detailed discussion of the need for such messages.

2.4.4.2. Effects of anger

Both of the threat scenarios increased reported feelings of anger, compared to baseline. The anger experienced after reading each threat scenario was significantly correlated with some of the focal cognitive variables. For both scenarios, anger showed positive correlations with perceived risk, and negative ones with resilience, coherence of probability responses, and trust. After controlling for fear, baseline, and trait emotions, however, these correlations did not remain significant. Thus, our predictions for the effects of anger on cognitive responses were not supported. Instead, our results suggest that fear as well as baseline and trait emotions explained the relationship between anger and these focal variables.

Only under carefully controlled experimental conditions is it possible to tease out the differential effects of these specific emotions. For example, Lerner et al. (2003) gave half of their participants existing media messages known to evoke more fear than anger, and the other half existing media messages known to evoke more anger than fear. Our survey did not manipulate fear and anger separately. However, our analyses provide statistical controls for ‘naturally’ occurring emotions experienced after reading about domestic threats, allowing us to examine separate effects of fear and anger. Our results suggest that the fear experienced after reading about domestic threats, and not the related anger, is likely to affect people’s cognitive responses. Implications for risk messages are discussed in section 2.4.4.6.

2.4.4.3. Canadians versus Americans

Canadian participants were generally as fearful as but less angry than American participants. Such lower levels of anger may benefit the quality of one’s decisions. People who are less angry tend to ponder more alternatives and think more deeply than people who are angry (Lerner & Tiedens, 2006; Tiedens & Linton, 2001).

However, Canadian and American participants reported a similar increase in experienced fear and experienced anger after reading the risk scenarios, compared to baseline. Thus, once they were exposed to risk information, participants experienced similar emotional changes, independent of their country of residence. Because our subsequent analyses focused on how these changes in emotions affected cognitive responses, there was no need to conduct separate analyses for Canadians and Americans. Moreover, there is no reason to believe that, once emotions are heightened, Canadians and Americans would experience different effects on their cognitive responses.

Thus, we expect that both Canadians and Americans may judged higher risk, feel less resilient, and be more compliant, when facing domestic threats that make them feel more fearful than usual.

2.4.4.4. Coherence of probability judgments

We presented a more in-depth analysis of one variable, reflecting the coherence of probability responses, following work by Mandel (2005). As explained above, we examined coherence by measuring whether the probabilities assigned to (a) complementary events (e.g., buying masks versus not) add up to 100%, and (b) conjunctions are smaller than or equal to those assigned to constituent events. The study of coherence is based on the heuristics and biases program (for an overview, see Kahneman, Slovic, & Tversky, 1982). The ability to produce coherent probability judgments is relevant to making better decisions about domestic threats, and which mitigation strategies to implement. Indeed, decision makers who produce more coherent probability judgments tend to obtain better real-world decision outcomes (Bruine de Bruin et al., 2007; Parker & Fischhoff, 2005).

As suggested by Mandel (2005), increasing the transparency of the relationship between two items by presenting them together, rather than separately, generally increased the coherence of judged probabilities for complementary pairs. Thus, when the relationship between complementary items was made apparent by their being presented together, participants were able to produce probability responses that add up to 100%. These results suggest that we can help people to make better decisions about risk by simply providing decision aids that present decisions about complementary events together – without necessarily having to explain what the complementary rule entails.

In contrast, probability responses to conjunction/constituent pairs were more coherent when being presented separately. Being made aware of the relationship between a conjunction and one of its conjoint events by presenting them together did not improve but rather impaired coherence. Possibly, our participants applied the representative heuristic, a rule of thumb to give higher probability judgments to items that ask about events that seem to be more representative of the consequences of domestic threats (Kahneman & Tversky, 1973). For example, events about which more details are known (e.g., getting sick from bird flu *and* dying, not having enough food *nor* essential supplies when sheltering from the fallout of a dirty bomb for 24 hours) may seem more representative of the kind of story one would tell if the related domestic threat occurred. However, according to the rules of probability theory, such conjunctions are actually less likely than its constituent events (e.g., getting sick from bird flu, which may or may not be followed by death; not having enough food when sheltering from fallout, which may or may not coincide with not having enough essential supplies). Thus, decision aids that aim to support people in making decisions about risks involving conjunction/constituent pairs may need to explain why the judged probability of a conjunction should be less likely or equal to the judged probability of an event that includes it.

2.4.4.5. Limitations

Because the presented results are based on correlational data, the direction of causality is unclear. For example, consider the negative correlation between fear experienced after reading about a domestic threat and judged resilience. One explanation for that result may be that the experienced fear decreased feelings of resilience. Another explanation may be that feeling less resilient caused fear in our participants. Alternative explanations may also include a third variable, causing both increased fear and reduced feelings of resilience: Domestic threats may make people feel out of control, thus increasing their fear and decreasing their feelings of resilience.

To examine whether specific emotions do indeed cause different cognitive responses, some emotion researchers have manipulated fear and anger. For example, after the terrorist attacks on 9/11, Lerner et al. (2003) randomly assigned American participants to materials that made them more fearful (but not more angry) or made them more angry (but not more fearful.) They found significant differences between participants in the fear and anger conditions, with the former seeing more risk than the latter. A similar emotion manipulation might be used to examine whether fear and anger cause the cognitive responses studied here. However, without the experience of the actual threat, emotion manipulations may not be as strong.

Indeed, another limitation of the project 1 surveys is that participants did not actually experience the threats. Under the conditions of an actual threat, emotions would likely have been stronger, with potentially different effects on cognitive responses.

Finally, it is important to note that the surveys were conducted with samples of convenience. As a result, the Canadian and the American samples may not be representative of their respective populations. However, research with a representative sample of Americans has found a similar relationship between fear and risk judgments as the one reported here (Lerner et al., 2003). Although such research has not been conducted with a representative sample of Canadians, the

interplay between their emotional and cognitive responses is likely to be similar. Effects of fear on resilience and compliance should be studied in nationally representative samples.

2.4.4.6. Implications

Overall, these results suggest that specific emotions are relevant to understanding public responses to domestic threats. Especially fear can affect citizens' risk judgments, as well as undermine their resilience and compliance with recommended mitigation strategies. Thus, fear and related responses must be considered in formulating a behaviorally realistic risk management approach. The psychological literature suggests that one effective fear reduction strategy involves providing people with control. For example, post-traumatic stress syndrome can be prevented in torture victims if they are psychologically prepared for it happening (Basoglu et al., 1997). Even animals are less distressed about aversive events if they are predictable and controllable (Basoglu & Mineka, 1992). In the context of domestic threats, citizens may feel more control if they are taught behaviorally realistic strategies that they can effectively implement to reduce their risk.

Effective risk messages include a science-based approach, formative research with its intended audience, and a focus on behavioral skills (e.g., Kim et al., 1997; McKay, 2000). The mental models approach provides one systematic procedure for developing effective interventions, explicitly including each of these elements (M.G. Morgan et al. 2001). First, an in-depth review of the scientific literature, reviewed by domain experts, shapes a decision-relevant summary of information needed to make informed decisions. Second, lay beliefs affecting consumers' decisions are extracted from in-depth interviews, preserving their intuitive ways of thinking. Third, intervention content is based on a comparison of lay and expert beliefs, and reviewed by experts *and* individuals drawn from the target audience. As a result, it should present lay people with decision-relevant information, in ways that both make intuitive sense to them and afford a common language with experts. The result should not only address lay people's informational needs in lay terms, but be perceived as doing so, in order to promote trust between the source and target of the intervention. The mental models approach has been used to teach lay audiences about a variety of risks, including cryptosporidium in the drinking water (Casman et al., 2001), domestic radon (M.G. Morgan et al., 2001), sexually transmitted infections (Bruine de Bruin et al., in press, b; Downs et al., 2004), among other things (M.G. Morgan et al., 2001).

The messages provided in the studies presented here have been developed with input from experts, but have not benefited from systematic research with citizens, to examine whether they can understand and execute the recommended mitigation strategies (i.e., wearing a mask to reduce the risk of contracting bird flu, and sheltering in place during a dirty bomb threat.) In addition, their effectiveness may be limited because their content appears to increase fear, compared to baseline. To improve the effectiveness of the presented messages, they should be tested with members of the intended audience. Effective messages should improve knowledge, facilitate the adoption and the effective execution of risk reduction strategies, and reduce counterproductive emotions such as fear.

3. Project 2: Relocation decisions following fallout contamination from a nuclear explosion

3.1. Introduction

An attack using a stolen or improvised nuclear bomb would not only lay waste to a blast zone several miles in diameter, but would blanket communities that were dozens of miles downwind with radioactive fallout, requiring prompt evacuation. After fallout had settled to the ground, radiation levels would decline with time due to radioactive decay. Within the first six months after the blast, radiation levels would decrease by roughly a factor of ten for every factor-of-seven increase in time since the blast. Beyond six months, radiation levels would decline even faster (Glasstone & Dolan, 1977). One day or so after the blast, radiation levels in downwind fallout zones that have been unaffected by the blast are not immediately lethal, but can increase long-term cancer risks for those exposed. Thus, the decision of when to return to the fallout-contaminated area involves a trade-off between the costs of remaining away from home and the costs of increased cancer risk. Other costs of returning to a previously evacuated area may include limited social services and vacant homes and businesses. The costs of remaining evacuated may include lost work and business opportunities. There also may be health costs arising from the stress of dislocation (e.g., lost income, inconvenient circumstances, family tensions, difficulty maintaining healthcare regimes). The faster that people return to their normal lives, the smaller will be the social and economic impacts of an attack to the affected community. However, the decision to return to home needs to be dealt with responsibly in the context of radiological contamination. Determining the acceptable risk level requires a social process that considers the costs and benefits associated with different possible clean-up levels.

Radiological risks arise in many contexts, from nuclear weapons to medical treatments. Each context has developed its own way of establishing acceptable exposure standards. These reflect not only the costs and benefits of abiding by possible standards, but also the social context within which they are set (e.g., the debates over nuclear power, the secrecy of 1950s weapons tests). A comprehensive analysis of decontamination standards, in any context, would consider all these effects, then determine acceptable tradeoffs. There is no logical reason why the exposure standards developed in one context should be mechanically adopted elsewhere, with differing control options and distributions of risks and benefits (e.g., for radiation exposure to patients and healthcare practitioners, for nuclear power plants and hazardous waste sites). Moreover, all standards reflect an imperfect resolution of conflicting political and economic pressures. Hence, they will likely have inconsistencies in terms of the protection bought per dollar spent (Tengs & Wallace, 2000).

In this project, we examine government standards for reoccupation following a radiological emergency that is sufficiently serious to have required the evacuation of people from their homes, and the suspension of business activities at workplaces within the contaminated zone. In 2003, as part of its responsibilities under Canada's Federal Nuclear Emergency Plan, Health Canada issued recommendations for reoccupation that called for people to return to their communities only when individual dose rates have fallen to less than 50 mSv/year (Health Canada, 2003). This corresponds to an incremental lifetime cancer risk of approximately one chance in 400 for radiation exposure received during the first year of reoccupation. Whether or not an evacuee would be willing to assume such a risk in return for having his/her house or job back is a complex personal decision. As far as can be determined by review of the guidance document (Health Canada, 2003),

the process by which Health Canada derived these reoccupation guidelines did not explicitly involve the lay public. Rather, the guidelines seem to be the result of expert deliberation alone.

Reoccupation guidelines from other scientific and regulatory bodies do not differ significantly from the Health Canada guidelines. For instance, the International Commission on Radiological Protection (ICRP 1993) recommends reoccupation only if doses are less than 5-15 mSv/month. The U.S. Environmental Protection Agency (USEPA, 1992) recommends reoccupation only if the additional lifetime dose is less than 50 mSv. For nuclear weapon fallout, both of these dose criteria are comparable to the annual criteria of Health Canada because fallout dose rate decreases rapidly over time.

Here, we present a model of this decision, to be used as a basis for developing standards that are behaviorally realistic. Radiological contamination from terrorists events require their own clean-up standard, informed by scientific research and social values. In the absence of an explicitly developed and adopted standard, multiple competing ones may be advocated, adding confusion to an already stressful situation. The winner in this competition may be poorly suited to these special circumstances. In particular, they may be much more stringent than citizens want. In time of national emergency, a small increase in lifetime cancer risk might or might not be an acceptable price to pay for returning to home and work.

3.2. Model

As indicated above, project 2 examines government standards for reoccupation following a radiological emergency that is sufficiently serious to have required the evacuation of people from their homes and the suspension of business activities at workplaces within the contaminated zone. Implicit in such standards are trade-offs involving the health and welfare of evacuated individuals. Such value-laden decisions are more legitimate when potentially affected citizens are included in the decision-making process. To this end, we have developed a normative conceptual model of various decision attributes that ought to factor into individuals' decisions on whether and when to return home following evacuation from their fallout-contaminated community. The model provides a basis for design of a survey aimed at eliciting citizens' judgments about trade-offs involved in the reoccupation decision. The model combines information about the physical processes relating to fallout radiation, biological processes relating to cancer risk from radiation exposure, and various economic, social, and psychological factors that affect wellbeing. The model was assembled by the authors, which include experts in both radiation protection (Florig) and human behavior (Bruine de Bruin, Fischhoff, Downs, and Stone). Part of the expert analysis was recently published in *Health Physics* (Florig & Fischhoff, 2007).

Figure 8 lays out the components of such a decision from the perspective of the family unit. In this model, the family has three housing options at any time: reoccupy their former home, remain longer in temporary housing, or relocate to new permanent housing. The family's utility realized by each option is dependent upon the discounted value of family health, perceived risk of past and future radiation exposure, family financial resources (including employment status), public service availability (e.g., police, shopping, schools), quality of living quarters, and community integrity (e.g., fraction of neighbors who have returned).

In composing this model, we consulted the literature on refugee return decisions. Black et al. (2004) reviewed this literature and conducted focus group interviews of dozens of refugees in the UK, assessing the importance of five categories of factors in the decision of whether or not to return to the refugee's home country: (1) Conditions in the country of origin; (2) Conditions in the host country; (3) Individual attributes (e.g., age and gender); (4) Social relations (e.g., spouse, children); (5) Policy incentives and disincentives. Black et al. (2004) found that safety and security in the home country dominated other considerations. Social factors (e.g., wanting to be with family) were a clear second, followed by economic considerations.

The similarities between refugees and evacuees from a radiological emergency are limited. Clearly, risk levels for refugees returning to violence-torn or politically-oppressive regions may be much higher than cancer risks in reoccupied fallout-contaminated communities. Refugees face the stress of adapting to another national culture, whereas evacuees do not. Refugees may be separated from loved ones for very long periods, whereas evacuation during a radiological emergency is not likely to severely impact the ability of family members to see each other. Despite these obvious differences, the five factors investigated by Black et al. have clear analogues in the evacuation case. Figure 8 is an attempt to capture them.

Government decision options (boxes in Figure 8) with direct impacts on the utility (to the family) of each housing option include issuing a reoccupation dose rate guidance or standard, distributing communications on radiation risk, and providing various kinds of support for housing, employment, community services, and radiation cleanup. Other than their housing decision per se, evacuees can make decisions (ovals) to modulate their family's risk by using personal resources to hire radiation decontamination services (if not available through the government), and undertake risk reduction measures unrelated to radiation (e.g., quit smoking, exercise) to compensate for added radiation risk. The rounded rectangles represent chance nodes that may affect, or be affected by, government and family decisions.

3.3. Survey

3.3.1. Hypotheses

The main goal of project 2 was to examine whether lay people's decisions to return home are affected by the absolute levels of cancer risk, and its relative importance in comparison to other factors, such as characteristics of their household, their neighborhood, and temporary housing. To the best of our knowledge, no one has ever explicitly and systematically elicited citizens' preferences regarding these questions. Rather, policies regarding contaminated areas are typically resolved by expert panels, reflecting an unclear set of values. That is, it is unclear whether they use their own, those that they attribute to citizens, or ones that they believe that citizens should endorse. Although it is possible to speculate regarding what citizens will say, the objective of this study is to develop and demonstrate a methodology capable of revealing these values. Hence, we had no specific hypotheses. The research literature on value elicitation is summarized in Fischhoff (2005b).

In addition, we examined whether decisions were affected by whether they are made for one's own household or for others. Previous research examining how people make decisions for others has found that people decide differently for others than for themselves under a number of different circumstances (e.g., Beisswanger et al., 2003; Kray & Gonzalez, 1999; Wray & Stone, 2005). One explanation for these self-other differences is that when deciding for others, people's decisions are determined largely by their perception of what is socially valued (Stone & Allgaier, 2007). Thus, if risk taking is valued, people will make risky decisions for others. If risk taking is not valued, people will make risk-averse decisions for others. Although the value placed on risk clearly influences personal decisions as well, it has a stronger influence on decisions made for other people.

In situations involving physical safety, there is a strong social value associated with that safety and, conversely, against risk (Stone & Choi, 2007). Thus, we hypothesized that participants would make particularly risk-averse decisions for others under conditions of domestic threats, leading to riskier decisions for the self than for another person. Specifically, we predicted that participants would advise others to wait longer than they themselves would wait until returning home after a nuclear explosion.

3.3.2. Method

3.3.2.1. Participants

Projects 1 and 2 used the same participants (see section 2.4.2.1.)

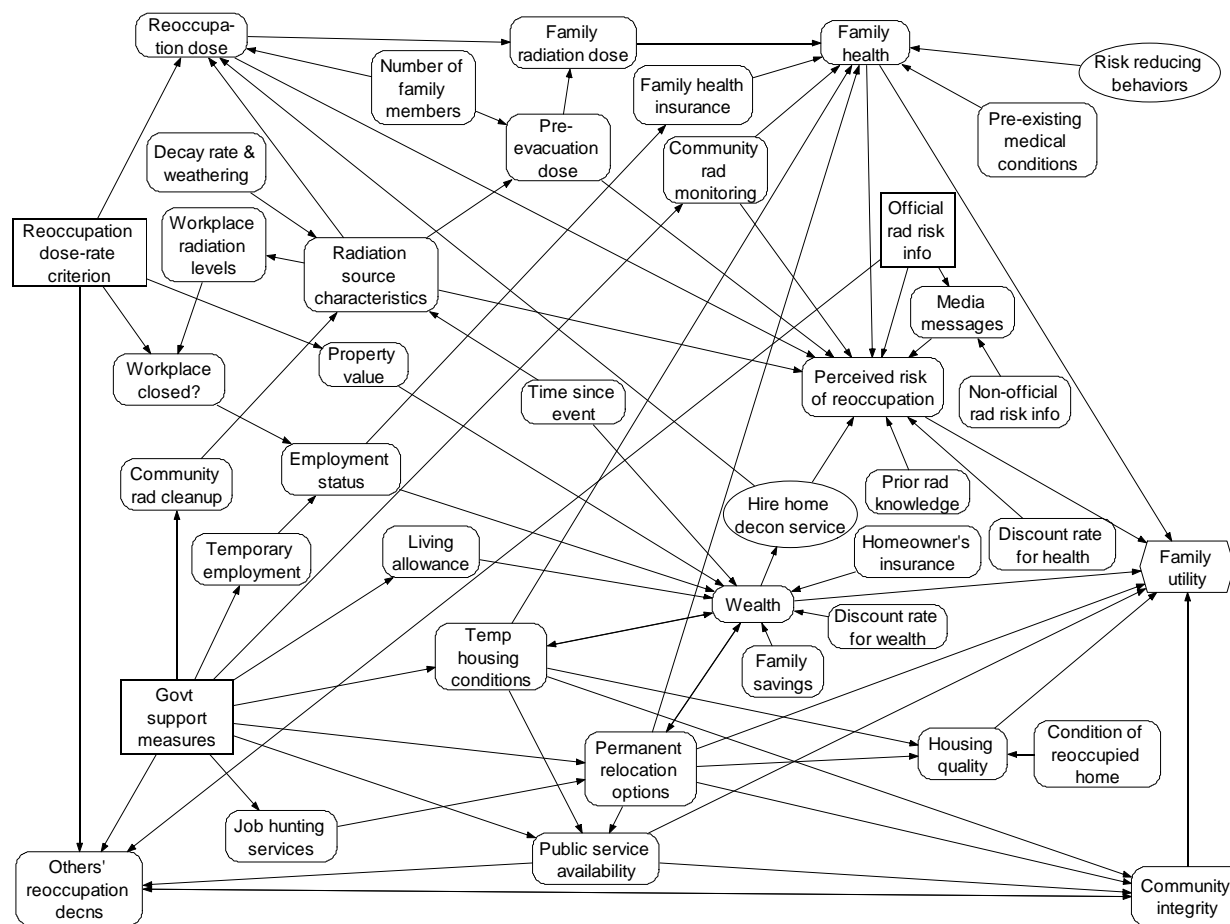


Figure 8: Model of family's decision to reoccupy their home following a radiological event leaving their neighborhood contaminated, showing interactions with various government decisions (in blue) and family decisions (in pink)

3.3.2.2. Procedure

The project 2 survey on relocating after a nuclear bomb explosion is presented in Annex G. Participants received project 1 and 2 materials, the order of which was counterbalanced across participants. For project 2, they read a scenario about a “nuclear bomb attack,” asking them to “imagine that terrorists set off a nuclear bomb somewhere in our country.” Participants recruited in Canada and in the U.S. received the same information, with distances from the nuclear blast being presented in terms of kilometers as well as miles. After being shown how radiation levels decrease over time, they were first asked when the government should allow people to move back to their homes, and how long the government should provide free housing to evacuees, with response options ranging from 1 day to more than 4 years, and an additional one stating that “people should be allowed to return to their homes, if they want to, no matter how high the risk level – as long as they know what the risk is” for the first question, and “the government should not provide free housing at all” for the second.

Subsequently, participants were asked to imagine “that the nuclear blast occurred in your area and that you were at home at the time” and their decision of when to return home. Participants were randomly assigned to the high-risk or the low-risk condition, with each being shown a different graph.⁴ Participants in each condition received text and a graph explaining the average days of life lost from fall-out radiation exposure for different time periods before returning home. As seen in Figure 9, the *low-risk* condition (left-hand graph) suggested that average life expectancy lost was 10 days at the time of the blast, decreasing to approximately 4 after 6 months. In the *high-risk* condition (right-hand graph), average life expectancy lost was 1,000 days at the time of the blast, decreasing to approximately 400 after 6 months. In both conditions, lost life expectancy in days returned to “a few days” or near-zero values after 20 years.

Comprehension of the graph was tested, by asking participants to figure out the duration of life lost in number of days lost 1 week, 3 months, 1 year, and 4 years post-attack. Subsequent questions asked how long they would wait until returning to their neighbourhood, if they were given free temporary housing indefinitely, or if they were given no support for temporary housing.

The next question asked participants to rate the importance of several factors in deciding when to move back, including the cancer risk from the radioactive fallout, your financial situation, the quality of life in temporary housing, whether you miss your home and your neighborhood, whether government authorities say it is safe to move back, the quality of your health insurance plan (in case you develop cancer), your current health and that of those living with you, and whether you are given a monitor to keep track of the amount of radiation to which you have been exposed. This list of decision factors was identified in pilot interviews, in which interviewees were asked to think aloud while deciding whether or not they would return, and to elaborate on their reasoning. Each factor was rated on a scale of 1 (verbally labeled “not important”) to 7 (verbally labeled “very important”).

⁴ The first fifty participants recruited in the U.S. all received the high-risk condition, and thus were not randomly assigned to risk condition. To be safe, they were excluded from all analyses related to project 2. Including them did not affect whether or not the reported analyses were significant ($p < .05$), except that it created a significant difference of risk condition on the percent of participants advising friends not to return, and a significant effect of the factor “government authorities say it’s safe to move back” significant for all variables reflecting how long participants would want to wait until returning home (Table 9). However, overall conclusions are not affected.

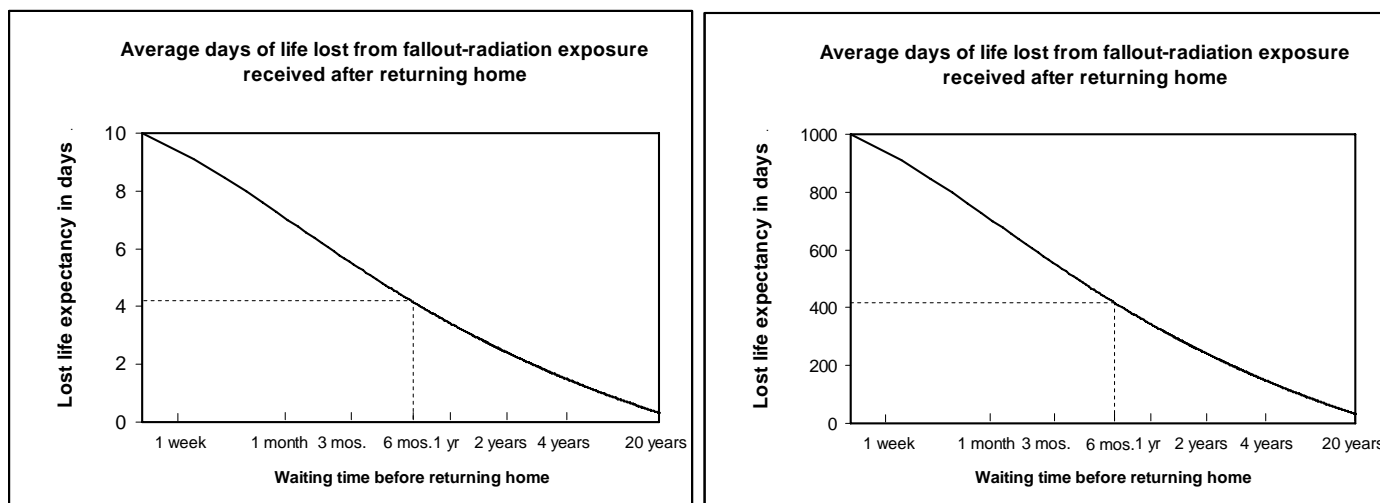


Figure 9: Graphs presented in low-risk condition (left) and high-risk condition (right)

Next, participants were asked how long they would recommend friends to wait until returning home, if free temporary housing was given indefinitely, and if no support for temporary housing were given, using the same questions and response options as before. They were then asked to rate the same factors as before, in terms of how important they should be to the government’s decision about how long to provide free housing for an evacuated household.

After completing materials for both projects, participants completed Woloshin et al.’s (2001) 3-item measure of numeracy, which is shown in Annex H. The measure examined participants’ ability to understand numbers, which has been shown to be relevant to decision making (Peters et al., 2006). For example, the first item asked participants to imagine “that we flip a fair coin 1,000 times. What is your best guess about how many times the coin would come up heads in 1,000 flips?”

Finally, participants reported demographic information, including age, gender, and highest level of education completed. In addition, they answered questions about factors likely to be relevant in deciding how long to wait until returning home if their neighborhood were affected by a nuclear explosion, including income, ratings of their financial situation and healthcare plan, whether they rented or owned, the number of members in their household, the number of children for which they are responsible, and how long they have lived in their home, the percent of family members living in the area, whether they had friends or family elsewhere with whom they could imagine staying for an extended period of time.

3.3.3. Results

3.3.3.1. Descriptive statistics

Table 6 shows, for Canadian and U.S. participants, their mean age, mean rating of their financial situation, mean rating of their healthcare plan, mean number of years they lived in their home, mean number of family members in the area in which they live, as well as the percent owning their own home, living with others, responsible for children, and with friends living elsewhere with whom they could imagine living. Mean income, originally reported in categories of dollars, was converted into the midpoint of that category, expressed in terms of Canadian dollars. Canadians and U.S. participants differed with regard to each of these characteristics, possibly reflecting changes in sampling procedures as well as the overall populations in the different areas.

Table 6: Demographic characteristics.

Demographic Variable	Canadian participants	U.S. participants	Test of Difference
Age	M = 42.0 SD = 15.2	M = 49.0 SD = 14.8	$t(154) = 2.75^{**}$
Rating of finances	M = 4.3 SD = 1.5	M = 5.3 SD = 1.4	$t(154) = 4.07^{***}$
Income	M = \$53,000 SD = 28.337	M = \$80,591 SD = 29.041	$t(145) = 5.46^{***}$
Rating of healthcare plan	M = 4.9 SD = 1.5	M = 1.5 SD = 1.3	$t(154) = 3.30^{**}$
How long in home (years)	M = 7.6 SD = 9.7	M = 14.2 SD = 10.6	$t(153) = 3.89^{***}$
How many of family in area	M = 56.1% SD = 38.5	M = 80.0% SD = 25.0	$t(146) = 3.97^{***}$
Percent owning own home	51.5%	88.7%	$\chi^2(1) = 21.0^{***}$
Percent living with others	74.5%	92.2%	$\chi^2(1) = 6.72^*$
Percent responsible for children	22.6%	59.3%	$\chi^2(1) = 21.09^{***}$
Percent with friends elsewhere	63.5%	94.1%	$\chi^2(1) = 16.53^{***}$

Note: *** $p < .001$; ** $p < .01$; * $p < .05$.

3.3.3.2. Graph comprehension and numeracy

Cronbach's alpha was sufficient across items measuring graph comprehension ($\alpha = .58$) but not across numeracy items ($\alpha = .51$). Combined, the two measures showed somewhat better internal consistency ($\alpha = .64$), with an unrotated factor analysis showing that all items loaded over .45 on the first factor. Hence, subsequent analyses only control for a summary measure across graph comprehension and numeracy items. On average, participants answered 53.8% ($SD = 27.1$) of these questions correctly, showing no difference between American and Canadian participants ($p > .10$).

3.3.3.3. Time to wait until returning home by risk condition

For the questions about how long to wait until returning home, all analyses using the “1 day” to “I would never return” response options were reverted to a 1-10 point scale. Table 7 shows, for the low-risk and high-risk condition, how long they wanted to wait until returning home, if free housing were available, and if it were not, and how long they would advise a friend to wait until returning home, if free housing were available, and if it were not. Table 7 also shows the percent of participants who did not want to return home, in each of these conditions.

Comprehending complex numerical information, as reflected in participants' score on the numeracy and graph comprehension measure, was related to how long participants wanted to wait until returning home. That is, participants with a better understanding of complex numerical information wanted to wait longer until returning home if free housing were available ($r = .25, p < .01$), showing a similar but marginally significant correlation for free housing being unavailable ($r = .14, p < .10$). When advising friends, they also suggested waiting longer if free housing were available ($r = .22, p < .01$) and if it were not ($r = .21, p < .05$). Hence, the analyses reported below controlled for participants' understanding of complex numerical information.

Correlations between responses for self or for friends were not related to participants' country of residence, age, ratings of their overall financial situation, actual income, ratings of the quality of their health care plan, whether they owned or rented their home, how long they had lived in their current home, whether they lived alone or with others, whether they are responsible for any children, the percent of family members who live in the area, having friends or family outside the area with whom they could imagine staying for an extended period of time ($p > .05$). Hence, the analyses reported below do not control for these variables.

Table 7: How long to wait until returning home.

	Low Risk				High Risk			
	Percent not returning	Median	Mean	SD	Percent not returning	Median	Mean	SD
Self								
With housing	16.5%	"6 months" (= 5)	5.79	2.73	30.9%	"4 years" (= 8)	7.26	2.57
Without housing	13.9%	"6 months" (= 5)	5.26	2.68	32.1%	"2 years" (= 7)	6.94	2.93
Friend								
With housing	13.9%	"6 months" (= 5)	5.81	2.65	23.5%	"4 years" (= 8)	7.23	2.50
Without housing	13.9%	"6 months" (= 5)	5.25	2.79	25.9%	"2 years" to "4 years" (= 7.5)	7.16	2.67

We conducted a repeated-measures multivariate analysis of variance (MANOVA) comparing the time participants wanted to wait until returning home when housing was available (versus not), by between-subjects conditions varying risk (high versus low). Unlike what we expected, the time participants wanted to wait until returning home was affected by their risk condition, $F(1, 152) = 13.63, p < .001$, as well as the availability of free housing, $F(1, 152) = 14.12, p < .001$. As seen in Table 7, participants wanted to wait longer when risk was high (versus low), and when free housing was available (versus not). There was no significant interaction effect ($p > .05$). After controlling for graph comprehension and numeracy, the effect of the risk condition remained significant, $F(1, 141) = 10.64, p < .01$, suggesting that potential difficulties in understanding the complex numerical information could not explain the effect of risk condition. Although the main effect of free housing did not remain significant ($p > .05$), there emerged a significant interaction between risk and the availability of free housing, $F(1, 141) = 4.52, p < .05$, reflecting that participants were less sensitive to the availability of free housing when the risk was high (Table 7).

Chi-square tests examined the effect of risk condition on whether or not participants were ever willing to return home under conditions of low versus high risk replicated this result. That is, participants were less willing to return home under conditions of high risk, whether free housing would be available, $\chi^2(1) = 5.45, p < .05$, or not, $\chi^2(1) = 7.71, p < .01$.

This pattern of results was replicated for the advice participants would give to friends about how long to wait until returning home. There was a significant effect of the risk condition, $F(1, 142) = 16.41, p < .001$, and the availability of free housing, $F(1, 139) = 6.32, p < .05$, with participants wanting friends to wait longer when risk was high (versus low), and when free housing was available (versus not). There was a significant interaction between housing and availability of free housing, $F(1, 142) = 4.65, p < .05$, again reflecting that participants were less sensitive to the availability of free housing under conditions of high risk. After controlling for graph comprehension and numeracy, the main effect of the risk condition remained significant, $F(1, 141) = 10.64, p < .01$, but the main effect of free housing did not, $F(1, 141) = .50, p = .48$. The interaction remained significant, $F(1, 141) = 4.52, p < .05$.

Chi-square tests found no effect of the risk condition on whether or not participants advised friends to never return if free housing were available ($p > .10$). There was a marginally significant difference between risk conditions with available free housing, $\chi^2(1) = 3.66, p = .06$. However, both patterns were in the same direction as analyses on decisions for participants themselves (Table 7).

3.3.3.4. Time to wait until returning home for self versus others

We conducted a within-subjects analysis comparing the time participants wanted themselves versus friends to wait under conditions of high versus low risk, with free housing being available versus not. There was no significant main effect of making the decision for one's own or for friends' households, or any significant interactions with this variable ($p > .10$).

We conducted this analysis again, separately for participants who lived alone and participants who lived with others. Again, we found no significant main effect of making the decision for one's own or for friends' households, or any significant interactions with this variable ($p > .10$).

In addition, we compared whether participants advised friends to never return, with whether they would return themselves. Wilcoxon signed rank tests showed a marginally significant difference with free housing available ($z = 1.73, p < .10$), with 25% opting to never return themselves and only 20% advising friends to stay away, and no significant difference without free housing available ($p > .10$).

3.3.3.5. Rated importance of factors

To compare the rated importance of cancer risk with the rated importance of other factors, we conducted a repeated-measures MANOVA, using a contrast comparing each factor with cancer risk, by high versus low risk. There was no significant difference between ratings of cancer risk and the overall health of participants and that of those living with them ($p > .10$). All other variables were rated as significantly less important than the cancer risk from the radioactive fallout, including participants' financial situation, $F(1, 154) = 19.28, p < .001$, the quality of life in temporary housing, $F(1, 154) = 35.59, p < .001$, whether participants miss their home and their neighborhood, $F(1, 154) = 110.95, p < .001$, whether government authorities say it is safe to move back, $F(1, 154) = 28.06, p < .001$, the quality of participants' health insurance plan, $F(1, 154) = 13.09, p < .001$, and whether they are given a monitor to keep track of the amount of radiation they have been exposed to, $F(1, 154) = 22.93, p < .001$. These comparisons did not interact with risk level, except for marginally significant interactions for the quality of life in temporary housing, $F(1, 154) = 3.37, p = .07$, and whether participants missed their home and their neighborhood, $F(1, 154) = 3.01, p = .09$. As opposed to cancer risk, which was rated as more important by participants in the high-risk than those in the low-risk condition, these measures were rated as more important in the low-risk than in the high-risk condition.

Table 8: The rated importance of each factor in deciding how long to wait until returning home.

	<i>M</i>	<i>SD</i>	Beta values for linear regressions predicting time to wait until returning home			
			For self, with Housing	For self, without housing	For friend, with housing	For friend, without housing
The cancer risk from the radioactive fallout	6.08	1.32	.42***	.50***	.50***	.45***
Your financial situation	5.28	1.87	.06	.00	.03	.00
The quality of life in temporary housing	5.11	1.75	-.09	-.16 ⁺	-.04	-.06
Whether you miss your home and your neighborhood	3.99	1.91	-.29***	-.23**	-.23**	-.28***
Whether government authorities say it's safe to move back	5.25	1.67	-.14 ⁺	-.11	-.16 ⁺	-.12
The quality of your health insurance plan (in case you develop cancer)	5.50	1.76	.06	-.01	.05	-.03
Your current health and that of those living with you	6.15	1.35	.01	-.01	.03	.08
Whether you are given a monitor to keep track of the amount of radiation to which you have been exposed	5.23	1.91	-.02	.07	-.05	-.01

Note: *** $p < .001$; ** $p < .01$; * $p < .05$; + $p < .10$.

To examine whether ratings of the degree to which these factors were rated as important were related to participants' reported decisions, we conducted linear regression on the time participants wanted to wait until returning home, using these factors as predictors. Table 8 shows that the cancer risk from the radioactive fallout was the most important factor in participants' decisions, with free housing available, or not available, whether they were deciding for themselves or advising their friends. On average, participants who rated this factor as more important wanted to wait longer until returning home. The other factor that was significant for each of these decisions was whether participants missed their home and their neighborhood. Participants who rated the factor as less important wanted to wait longer. There was a marginally significant correlation between the rated importance of the factor in the government's decision about whether it would be safe to move back and the time participants wanted their own household or a friend's household to wait, if free housing were not available. Those who rated the variable as less important wanted to wait longer until returning home.

An additional analysis of participants' desired government's decision showed similar results. Here, the most important factor was the cancer risk from the radioactive fallout. This risk was rated as more important than the financial well-being of those evacuated, $F(1, 156) = 37.27, p < .001$, the quality of life in temporary housing, $F(1, 156) = 53.15, p < .001$, whether evacuees believe it's safe to move back, $F(1, 156) = 50.60, p < .001$, the quality of the health insurance plan of the evacuated household (in case they develop cancer), $F(1, 156) = 33.73, p < .001$, the overall health of members of the evacuated household, $F(1, 156) = 9.57, p < .01$, and the total number of households that need temporary housing, $F(1, 156) = 42.16, p < .001$. None of these ratings interacted with risk condition ($p > .10$) or whether participants lived with others ($p > .10$).

Table 9 shows the importance of different factors, in the government's decision about how long to provide free housing. Here, the cancer risk was rated as the most important. A repeated-measures MANOVA compared ratings of each factor with ratings of the cancer risk factor, by risk condition. It showed that the cancer risk factor was rated as more important than each factor in Table 9 ($p < .01$). Interactions with risk factor were not significant ($p > .10$).

A linear regression on participants' beliefs reflecting how long the government should provide free housing showed a marginally significant relationship with the rated importance of the cancer risk from the radioactive fallout, and a significant relationship with the importance of the rated importance of the quality of the health insurance plan of evacuated households.

Table 9: The rated importance of each factor for the government's decision how long to provide free housing

	<i>M</i>	<i>SD</i>	Beta values for regression
The cancer risk from the radioactive fallout in the evacuated neighborhood	6.43	.97	.18*
The financial well-being of those evacuated	5.65	1.65	.05
The quality of life in temporary housing	5.60	1.51	.12
Whether evacuees believe it's safe to move back	5.47	1.57	-.05
The quality of the health insurance plan of evacuated households (in case they develop cancer)	5.61	1.71	.26*
The overall health of members of the evacuated household	6.06	1.39	-.14
The total number of households that need temporary housing	5.30	2.02	-.05

Note: * $p < .05$; + $p < .10$

3.3.4. Discussion

3.3.4.1. *Time to wait until returning home*

In the present study, the time participants wanted to wait until returning home after nuclear fallout had blanketed their neighborhood was affected by low risk versus high risk conditions, such that participants wanted to wait longer under conditions of high risk. Information about the (low versus high) risk was presented in a graph, accompanied by a written explanation. Although this risk information was presented in a complex graph, people were able to incorporate it into their decisions about how long to wait until returning home. Moreover, people's ability to understand complex risk information did not affect this pattern of responses.

The psychological literature suggests that survey responses are often affected by how information is presented (see, for an overview, Kahneman, Slovic, & Tversky, 1982; Schwarz, 1996). For example, graphical displays that represent risk in terms of asterisks increase risk avoidance compared to numerical displays (Schirillo & Stone, 2005; Stone et al., 1997). Our choice to present risk information in a graph may have affected the observed responses, especially in the high-risk condition, where waiting longer until returning home had a larger impact on risk reduction.

However, we found that participants also took into account radiation-related cancer risk when using two additional methods to examine their decisions about how long to wait until returning home after a nuclear bomb explosion. Each of these methods consistently suggested that the cancer risk from radioactive fallout was relevant to people's decisions. Thus, the differential responses observed in the high-risk condition, compared to the low-risk condition, can probably not be explained solely by the way risk information was presented.

First, when asked to rate the importance of different factors in deciding how long to wait until returning home, cancer risk from radioactive fallout was rated as one of the two most important factors. It was considered as important as the current health status of oneself and one's household members, and more important than perhaps more short-term concerns such as their financial situation and the quality of life in temporary housing. Although the other factors were considered less important than the cancer risk from radioactive fallout, all other factors also received relatively high ratings, with most showing an average rating above 5.00 on a scale from 1.00 (verbally labeled 'not important') to 7.00 (verbally labeled 'very important').

Second, when asked to rate how important different factors should be in the government's decision about how long to provide free housing, cancer risk from radioactive fallout was rated as the most important factor. As for the decision made for oneself, cancer risk from radioactive fallout was rated as more important than short-term concerns such as the financial situation of those evacuated, as well as the quality of life in temporary housing.

Third, ratings of the importance of cancer risk were most strongly related to how long participants wanted to wait until returning home, how long they advised friends to wait, and how long they believed the government should provide free housing. Thus, participants consistently believed that cancer risk from radioactive fallout was the most important factor to be considered, and seemed to take it into consideration when deciding how long to wait until returning to a neighborhood affected by radioactive fallout.

The rated importance of missing one's home and neighborhood was also consistently related to participants' decisions for themselves and for their friends, such that they wanted to return home sooner if they thought it was more important. However, overall, this factor was rated as the least important in making the decision to return home. As a result, it may not play a large role in decisions about how long to wait until returning to a neighborhood affected by radioactive fallout.

3.3.4.2. *Decisions for self versus decisions for others*

We also compared participants' decisions for their own household with advice they would give to others, regarding how long to wait until returning home. Based on previous research (Stone & Choi, 2007), we expected that safety would play a larger role in decisions for the self than decisions for others, leading participants to advise others to wait longer than they themselves would be willing to wait. However, we found that responses were not affected by whether participants lived alone or with others. When making decisions for their own household, participants would effectively have been making decisions for others. Indeed, the majority of the participants in this study lived with others. We conducted analyses for participants who lived alone, but may not have had enough power.

Previous research suggested that self-other differences are determined largely by people's perception of what is socially valued (Stone & Allgaier, 2007), with risky decisions being made for others in contexts in which risk taking is valued, and risk averse decisions being made for others in contexts in which avoiding risk is valued. When making decisions for oneself, however, people can often think of reasons why it would be better to choose the less socially valued option (Kray & Gonzalez, 1999). We expected self-other differences in the present survey, because of the strong social value associated with physical safety, and, possibly, avoiding cancer risk (Stone & Choi, 2007).

Possibly, we found no self-other differences because avoidance of cancer risk from radioactive fallout has so much value that people can not think of good reasons to take the risk -- even when they are making decisions for themselves. In addition, self-other differences are often not found for high-impact decisions (Allgaier & Stone, 2002; Beisswanger et al., 2003). Thus, self-other differences due to social values may be more likely to occur in decisions with less potential impact.

3.3.4.3. *Limitations*

The survey presented participants with hypothetical decisions about returning home, which may not be predictive of the actual decisions they would make, if they were faced with that situation. We present three reasons that have been suggested in the psychological literature.

First, people may be susceptible to the so-called hot-cold empathy gap (Loewenstein, 1999). It refers to the finding that people have different preferences when they are "hot" with an emotion than when they are "cold" and unemotional. Moreover, people who are in a cold unemotional state tend to underestimate how much they will be influenced by a specific emotional state. For example, pregnant women may prefer to avoid anesthesia when asked one month prior to child birth, ask for anesthesia during child birth, and switch to preferring to avoid anesthesia when asked one month after child birth (Christensen-Szalanski, 1984). Similarly, the emotions evoked while being evacuated after a nuclear terror threat may sway decisions in ways that our participants could not image while answering our survey questions.

Second, risk perceptions may change with experience. Research suggests that people who have been exposed to a risk without immediately experiencing a negative outcome may believe that the risk is lower than those who have never been exposed. For example, adolescents who have had sex or alcohol tend to judge the risks of these behaviors as lower than do abstainers (Benthin et al., 1993; Finn & Brown, 1981; Halpern-Felsher et al., 2001). In an experiment simulating fertility treatments, adult participants concluded after only a few failed treatments that they had no chance to conceive at all (Zikmund-Fisher et al., 2004). In part, these results may reflect unrealistically high risk perceptions among people who have never been exposed to a risk. In part, they may also reflect a tendency to rely unduly on initial outcomes for estimating future results (Tversky & Kahneman, 1993), and ignoring how risks mount up with increased exposure (Fischhoff, 1996; Linville et al., 1993; Shaklee & Fischhoff, 1990). Whatever the reason, these results do suggest that people who have not gotten sick despite having been exposed to radioactive fallout during the preparations for their evacuation, and on their evacuation route, may conclude that their risk for developing cancer is not as high as they initially may have thought.

Third, different decision factors may be salient when thinking about a hypothetical situation than when experiencing it (Loewenstein, 1999). When *thinking* about returning home after a nuclear terror threat, our participants were most concerned about reducing their cancer risk. If they were ever to *experience* that situation, they may be less concerned about that risk -- and more concerned about, for example, their finances. Indeed, a survey of Americans who evacuated after Hurricane Katrina suggests that lower-income homeowners were more likely to have intentions to return than higher-income homeowners (Elliott & Pais, 2006). Possibly, the combination of lower income and mortgage obligations prevented them from seeking alternatives to returning to New Orleans.

To address the potential discrepancies between hypothetical and actual decisions, follow-up research should be conducted with people who are experiencing evacuation, and making decisions about whether to stay or to return home. Existing surveys have asked evacuees mostly about their evacuation experiences (Brodie et al., 2006; Elliott & Pais, 2006), and relatively little their decisions to return home. However, their existence suggests that it is possible to recruit survey participants from evacuated populations.

These results were found with convenience samples of people residing in Toronto, Ontario (Canada) and Pittsburgh, Pennsylvania (United States of America). They differed in terms of almost all of the demographic characteristics we measured, with Canadian participants reporting being younger, feeling less secure about their financial situation, having less income, feeling more secure about their healthcare plan, having been in their homes less long, having fewer family members in their area, as well as being less likely to own their homes, more likely to live with others, less likely to be responsible for children, and less likely to have friends elsewhere with whom they could imagine staying for an extended period of time (Table 6).

Despite the many differences between the two samples, we found no differences between Canadian and American participants, in terms of their willingness to return home after a nuclear bomb has exploded in their neighborhood. Neither did we find significant effects of these demographic variables on the reported results. Possibly, Canadians and Americans of different backgrounds have similar concerns when considering the decision to return home, after a nuclear attack on their neighborhood.

However, neither Canadian nor American survey participants were representative of their respective populations. A nationally representative sample is needed to draw conclusions about the decisions Canadians and Americans would make when considering a move back to their homes after a nuclear bomb explosion occurred in their neighborhoods.

3.3.4.4. Implications

The reoccupation standards developed by Health Canada (2003) aim to reduce the cancer risk from radioactive fallout, and ignore other factors, such as evacuees' financial situation, or the quality of life in temporary housing. Our results suggest that these guidelines may reflect people's main concerns. In the hypothetical decisions made by our survey participants, reducing cancer risk was seen as the second most important factor to consider, and the only factor related to decisions about how long to wait until returning home. Yet, other factors, such as the quality of life in temporary housing, as well as one's overall financial situation, were also considered relevant. In a time of national emergency, these factors may weigh more heavily than a small increase in lifetime cancer risk.

To reflect citizens' concerns, it might be worthwhile to involve them in a reconsideration of existing standards. Our results suggest that lay people can make consistent decisions about whether or not to return home after having been evacuated to avoid the cancer risk from radioactive fallout. The mental models approach provides one systematic procedure for involving expert and lay beliefs to develop messages about risks (M.G. Morgan et al., 2001), and could also be applied to the development of reoccupation standards. The details of the approach are described in section 2.4.4.5.

Lay audiences have been successfully involved in making risk management decisions, showing relatively good agreement and satisfaction (Florig et al., 2001; K.M. Morgan et al., 2001; Willis et al., 2004). Such involvement may help policy makers to explain, and defend, reoccupation standards to the public. It may also make the standards more behaviorally realistic, in terms of taking into account citizens' preferences and concerns.

4. Closing comments

Managing risks is always an exercise in judgment. It requires identifying the relevant factors, creating potential responses, assembling the available evidence, adapting it to novel circumstances, integrating the diverse pieces, and evaluating the results (see Department of National Defence, 2002, 2004). The approach here incorporates emotional and behavioral components that affect how a risk unfolds. As such, the resulting findings can help to identify more behaviorally realistic responses to threats.

The models provide a first step towards understanding public responses to domestic threats, in terms of summarizing available scientific knowledge. A descriptive analysis, based on surveys with citizens, provide the second step. In project 1, we found that the fear experienced after being exposed to risk information can systematically affect risk judgments, feelings of resilience, and compliance with risk messages. In project 2, we found that people can nevertheless make consistent decisions about the domestic threat posed by a nuclear bomb explosion, aiming to reduce cancer risk from radioactive fallout even when other concerns may be pressing. Each project lead to specific suggestions for involving citizens in the development of risk messages and reoccupation standards.

Thus, we report consistent patterns in public responses to domestic threats, providing detailed information about the relationships shown in the models. Combined, the models and the survey data can serve as a basis for strategy design, risk management, and developing and evaluating risk communication.

5. References

- BARRY, J.M. (2004). *The great influenza*. New York, NY: Penguin Group.
- BASOGLU, M., & MINEKA, S. (1992). Role of uncontrollability and unpredictability of stress in the development of post-torture stress symptoms. In M. Basoglu (Ed.): *Torture and its consequences: Current Treatment Approaches*. Cambridge: Cambridge University Press.
- BASOGLU, M., MINEKA, S., & PAKER, M. (1997). Psychological preparedness for trauma as a protective factor in survivors of torture. *Psychological Medicine*, 27, 1421-1433.
- BEISSWANGER, A. H., STONE, E. R., HUPP, J. M., & ALLGAIER, L. (2003). Risk taking in relationships: Differences in deciding for oneself versus for a friend. *Basic and Applied Social Psychology*, 25, 121-135.
- BENTHIN, A., SLOVIC, P., & SEVERSON, H. (1993). A psychometric study of adolescent risk perception. *Journal of Adolescence*, 16, 153-168.
- BLACK, R., KOSER, K. and MUNK, K., ATFIELD, G., D'ONOFRIO, L.D., TIEMOKO, R. (2004), Understanding Voluntary Return, Home Office Online Report 50.04. <http://www.homeoffice.gov.uk/rds/pdfs04/rdsolr5004.pdf>
- Brodie, M., Weltzien, E., Altman, D., Blendon, R.J., & Benson, J.M. (2006). Experiences of Hurricane Katrina evacuees in Houston shelters: Implications for future planning. *American Journal of Public Health*, 96, 1402-1408.
- BRUINE DE BRUIN, W., DOWNS, J.S., & FISCHHOFF, B. (in press, b). Adolescents' thinking about the risks and benefits of sexual behavior. In: Lovett, M. & Shah, P. (Eds.) *Thinking with data*. Mahwah, NJ: Erlbaum.
- BRUINE DE BRUIN, W., FISCHHOFF, B., BRILLIANT, L., & CARUSO, D. (2006). Expert Judgments of Pandemic Influenza Risks. *Global Public Health*, 1, 178-193.
- BRUINE DE BRUIN, W., PARKER, A.M., & FISCHHOFF, B. (2007). Individual differences in Adult Decision-Making Competence. *Journal of Personality and Social Psychology*, 92, 938-956.
- BRUINE DE BRUIN, W., & PARKER, A.M., & FISCHHOFF, B. (in press, a). Can adolescents predict significant life events? *Journal of Adolescent Health*.
- BYRAM, S., FISCHHOFF, B., EMBREY, M., BRUINE DE BRUIN, W., & THORNE, S. (2001). Mental models of women with breast implants regarding local complications. *Behavioral Medicine*, 27, 4-14.
- CASMAN, E., FISCHHOFF, B., PALMGREN, C., SMALL, M., & WU, F. (2000). Integrated risk model of a drinking waterborne Cryptosporidiosis outbreak. *Risk Analysis*, 20, 493-509.
- CASMAN, E., FISCHHOFF, B., SMALL, M., DOWLATABADI, H., MORGAN, M.G., & ROSE, J. (2001). Climate change and cryptosporidiosis: A qualitative analysis. *Climate Change*, 50, 219-249.
- CLEMENS, R.T. (1997). *Making hard decisions: An introduction to decision analyses* (2nd edition). Belmont, MA: Duxbury.
- COHEN, S., & HERBERT, T.B. (1996). Psychological factors and physical disease from the perspective of human psychoneuroimmunology. *Health Psychology*, 15, 113-142.
- DEPARTMENT OF NATIONAL DEFENCE (2002). Risk Management for CF Operations: B-GJ-005-502/FP-000. Ottawa, Ontario: Department of National Defence.

DEPARTMENT OF NATIONAL DEFENCE (2004). Baseline study: Integrated risk management within the DND/CF: 1000-6-4 Ottawa, Ontario: Department of National Defence.

DHAMI, M. K., MANDEL, D. R., & SOUZA, K. (2005). Escape from reality: Prisoner's counterfactual thinking about crime, justice and punishment. In D. R. Mandel, D. J. Hilton, & P. Catellani (Eds.), *The psychology of counterfactual thinking* (pp. 165-182). New York: Routledge.

DOMBROSKI, M. (2005). *A framework for risk assessment of radiological dispersion device (RDD) events: Integrating physical dispersion and behavioral response models*. Doctoral dissertation, Carnegie Mellon University: Department of Engineering and Public Policy.

DOMBROSKI, M., FISCHHOFF, B., & FISCHBECK, P. (2006). Predicting emergency evacuation and sheltering behavior: A structured analytical approach. *Risk Analysis*, 26, 1675-1688.

DOWNS, J.S., MURRAY, P.J., BRUINE DE BRUIN, W., WHITE, J.P., PALMGREN, C. & FISCHHOFF, B. (2004). Interactive video behavioral intervention to reduce adolescent females' STD risk: A randomized controlled trial. *Social Science & Medicine*, 59, 1561-1572.

DUNN, J.R., & SCHWEITZER, M.E. (2005). Feeling and believing: the influence of emotion on trust. *Journal of Personality and Social Psychology*, 88, 736-748.

FINN, P., & BROWN, J. (1981). Risks entailed in teenage intoxication as perceived by junior and senior high school students. *Journal of Youth and Adolescence*, 10, 61-76.

FISCHHOFF, B. (May, 2006). Diagramming risks. *Harvard Business Review*, 8-10.

FISCHHOFF, B. (2005a). A hero in every aisle seat. *New York Times*, Sunday August 7, Section 4, p.13.

FISCHHOFF, B. (2005b). Cognitive processes in stated preference methods. In K-G Mäler and J Vincent, eds. *Handbook of Environmental Economics*. Elsevier, Amsterdam, pp. 937-968

FISCHHOFF, B. (2000). Scientific management of science? *Policy Sciences*, 33, 73-87.

FISCHHOFF, B. (1996). The real world: What good is it? *Organizational Behavior & Human Decision Processes*, 65, 232-248.

FISCHHOFF, B., BRUINE DE BRUIN, W., PERRIN, W. & DOWNS, J.S. (2004). Travel risks in a time of terror: Judgments and choices. *Risk Analysis*, 24, 1299-1307.

FISCHHOFF, B., BRUINE DE BRUIN, W., GÜVENÇ, U., BRILLIANT, L., & CARUSO, D. (2006). Analyzing disaster risks and plans: An avian flu example. *Journal of Risk and Uncertainty*, 33, 131-149.

FISCHHOFF, B., DOWNS, J.S. & BRUINE DE BRUIN, W. (1998). Adolescent vulnerability: A framework for behavioral interventions. *Applied and Preventive Psychology*, 7, 77-94.

FLORIG, H.K., & FISCHHOFF, B. (2007). Individuals' decisions affecting radiation exposure after a nuclear explosion. *Health Physics*, 92, 475-483.

Florig, H.K., Morgan, M.G., Morgan, K.M., Jenni, K.E., Fischhoff, B., Fischbeck, P.S., & DeKay, M.L. (2001). A deliberative method for ranking risks (I): Overview and test-bed development. *Risk Analysis*, 21, 913-921.

GLASS, T.A. (2001). Understanding public response to disasters. *Public Health Reports*, 116 (Supplement 2), pp. 69-73.

GLASSTONE, S. & DOLAN, P.J. (1977). *Effects of nuclear weapons (third edition)*. Washington, DC: U.S. Dept. of Defense and the Energy Research and Development Agency.

- GOLDBERG, J. H., LERNER, J. S., & TETLOCK, P. E. (1999). Rage and reason: the psychology of the intuitive prosecutor. *European Journal of Social Psychology*, 29, 781-795.
- HALPERN-FELSHER, B. L., MILLSTEIN, S. G., ELLEN, J. M., ADLER, N. E., TSCHANN, J. M., & BIEHL, M. (2001). The role of behavioral experience in judging risks. *Health Psychology*, 20, 120-126.
- HASTIE, R., & DAWES, R.M. (2002). *Rational choice in an uncertain world (second edition)*. San Diego: Sage.
- HEALTH CANADA. (2003). *Canadian guidelines for intervention during a nuclear emergency*. Ottawa, Ontario, Canada: Health Canada.
- HOUTS, P.S., CLEARY, P.D., & HU, T. (1989). *The Three Mile Island crisis: Psychological, social, and economic impacts on the surrounding population*. University Park, PA: The Pennsylvania State University Press.
- INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION (1993). Principles for Intervention for Protection of the Public in a Radiological Emergency. ICRP Publication 63, Pergamon Press, Oxford.
- JANIS, I.L. (1951). *Air war and emotional stress*. Westport, CT: Greenwood Press.
- JOHNSON, E.J., & TVERSKY, A. (1993). Affect, generalization, and the perception of risk. *Journal of Personality and Social Psychology*, 45, 20-31.
- KAHNEMAN, D., SLOVIC, P., & TVERSKY, A. (1982). *Judgment under uncertainty: Heuristics and biases*. Cambridge, UK: Cambridge University Press.
- KAHNEMAN, D., & TVERSKY, A. (1973). On the psychology of prediction. *Psychological Review*, 80, 237-251.
- KELLY, H. (2002). Dirty bombs: Response to a threat. *FAS Public Interest Report: Journal of the Federation of American Scientists*, 55(2), 1, 6-10.
- KIM, N., STANTON, B., LI, X., DICKERSIN, K. & GALBRAITH, J. (1997). Effectiveness of the 40 adolescent AIDS risk reduction interventions: A quantitative review. *Journal of Adolescent Health*, 20, 204-215.
- KRAY, L. J., & GONZALEZ, R. (1999). Differential weighting in choice versus advice: I'll do this, you do that. *Journal of Behavioral Decision Making*, 12, 207-217.
- LERNER, J. S., GONZALEZ, R. M., SMALL, D. A., & FISCHHOFF, B. (2003). Effects of fear and anger on perceived risks of terrorism: A national field experiment. *Psychological Science*, 14, 144-150.
- LERNER, J. S. & KELTNER, D. (2001). Fear, anger, and risk. *Journal of Personality and Social Psychology*, 81, 146-159.
- LERNER, J. S. & KELTNER, D. (2000). Beyond valence: Toward a model of emotion-specific influences on judgment and choice. *Cognition and Emotion*, 14, 473-493.
- LERNER, J. S., & TIEDENS L. Z. (2006). Portrait of the angry decision maker: How appraisal tendencies shape anger's influence on cognition. *Journal of Behavioral Decision Making*, 19, 115-137.
- LEVI, M.A., & KELLY, H. C. (November, 2002). Weapons of mass disruption. *Scientific American*, 287, 76-81.
- LINDELL, M.K. & PERRY, R.W. (1992). *Behavioral foundations of community emergency planning*. Washington, D.C.: Hemisphere Press.

- LINVILLE, P. W., FISCHER, G. W., & FISCHHOFF, B. (1993). Aids risk perceptions and decision biases. In J. B. Pryor & G. D. Reeder (Eds.) *The social psychology of HIV infection*. Hillsdale, NJ: Erlbaum.
- LOEWENSTEIN, G. (1999). Wouldn't it be nice? Predicting future feelings. In: Kahneman, D., Diener, E., Schwarz, N. (Eds.) *Well-being: The foundations of hedonic psychology* (pp. 85-105). New York: Russell Sage Foundation.
- LOEWENSTEIN, G., & LERNER, J.S. (2002). The role of affect in decision making. In R. Davidson, K. Scherer, & H. Goldsmith (Eds.), *Handbook of affective science*. (pp. 619-642). New York: Oxford University Press.
- LOEWENSTEIN, G.F., WEBER, E.U., HSEE, C.K., & WELCH, E. (2001). Risk as feelings. *Psychological Bulletin*, 127, 267-286.
- MANDEL, D.R. (2005). Are risk assessments of a terrorist attack coherent? *Journal of Experimental Psychology: Applied*, 11, 277-288.
- MCKAY, A. (2000). Prevention of sexually transmitted infections in different populations: A review of behaviourally effective and cost-effective interventions. *The Canadian Journal of Human Sexuality*, 9, 95-120.
- MORGAN, K.M., DEKAY, M.L., FISCHBECK, P.S., MORGAN, M.G., FISCHHOFF, B., & FLORIG, H.K. (2001). A deliberative method for ranking risks (II): Evaluation of validity and agreement among risk managers. *Risk Analysis*, 21, 923-937.
- MORGAN, M.G., FISCHHOFF, B., BOSTROM, A., & ATMAN, C. (2001). *Risk communication: The mental models approach*. New York: Cambridge University Press.
- NATIONAL COUNCIL ON RADIATION PROTECTION AND MEASUREMENTS (2001). *Management of terrorist events involving radioactive material* [NCRP Report No. 138]. Bethesda, MD: National Council on Radiation Protection and Measurements.
- PARKER, A. M., & FISCHHOFF, B. (2005). Decision-making competence: External validation through an individual-differences approach. *Journal of Behavioral Decision Making*, 18, 1-27.
- PETERS, E., VÄSTFJÄLL, D. SLOVIC, P., MERTZ, C.K., MAZZOCO, K., & DICKERT, S. (2006). Numeracy and decision making. *Psychological Science*, 17, 407-413.
- SCHIRILLO, J.A., & STONE, E.R. (2005). The greater ability of graphical versus numerical displays to increase risk avoidance involves a common mechanism. *Risk Analysis*, 25, 555-556.
- SCHWARZ, N. (1996). *Cognition and communication: Judgmental biases, research methods, and the logic of conversation*. Hillsdale, NJ: Erlbaum.
- SHAKLEE, H., & FISCHHOFF, B. (1990). The psychology of contraceptive surprises: Cumulative risk and contraceptive effectiveness. *Journal of Applied Psychology*, 20, 385-403.
- SMITH, C.A., & ELLSWORTH, P.C. (1985). Patterns of cognitive appraisal in emotion. *Journal of Personality and Social Psychology*, 48, 813-838.
- STONE, E. R., & ALLGAIER, L. (2007). *A social values analysis of self-other differences in decision making involving risk*. Working paper. Wake Forest University: Department of Psychology.
- STONE, E.R., & CHOI, Y.S. (2007). *Decisions for self versus others*. Working paper. Wake Forest University: Department of Psychology.

- STONE, E.R., YATES, J.F., & PARKER, A.M. (1997). Effects of numerical and graphical displays on professed risk-taking behavior. *Journal of Experimental Psychology: Applied*, 3, 243-256.
- STRUBE, M.J. (1985). Combining and comparing significance levels from nonindependent hypothesis tests. *Psychological Bulletin*, 97, 334-341.
- TIEDENS, L.Z., & LINTON, S. (2001). Judgment under emotional certainty and uncertainty: the effects of specific emotions on information processing. *Journal of Personality and Social Psychology*, 81, 973-988.
- TIERNEY, K. (2003). Disaster beliefs and institutional interests: Recycling disaster myths in the aftermath of 9-11. In L. Clarke (Ed.), *Research in social problems and public policy, Volume 11, Terrorism and disaster: New threats, new ideas* (pp. 33-52). St. Louis, M.O.: Elsevier.
- TILL, J.E., & MEYER, H.R. (Eds.) (1983). *Radiological assessment: A textbook on environmental dose analysis* [NUREG/CR-3332 ORNL-5968]. Washington, DC: Division of Systems Integration, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission.
- QUIGLEY, B.M., & TEDESCHI, J.T. (1996). Mediating effects of blame attributions on feelings of anger. *Personality and Social Psychology Bulletin*, 22, 1280-1288.
- TVERSKY, A., & KAHNEMAN, D. (1993). *Probabilistic reasoning*. In A. I. Goldman (Ed.), *Readings in philosophy and cognitive science*: Cambridge, MA, US, 1993, xi, 860.
- TVERSKY, A., & KAHNEMAN, D. (1983). Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment. *Psychological Review*, 90, 293-315.
- UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (1992). *Manual of protective action guides and protective actions for nuclear incidents*, EPA 400-R-92-001, Washington.
- WEEDN, V.W., MCDONALD, M.D., LOCKE, S.E., SCHREIBER, M., FRIEDMAN, R.H., NEWELL, R.G., & TEMOSHOK, L.R. (2004). Managing the community response to bioterrorist threats. *IEEE Engineering in Medicine and Biology Magazine*, 23(1), 162-170.
- WILLIS, H.H., DEKAY, M.L., MORGAN, M.G., FLORIG, H.K., & FISCHBECK, P.S. (2004). Ecological risk ranking: Development and evaluation of a method for improving public participation in environmental decision making. *Risk Analysis*, 24, 363-378.
- WOLOSHIN, S., SCHWARTZ, L.M., MONCUR, M., GABRIEL, S., & TOSTESON, A.N.A. (2001). Assessing values for health: Numeracy matters. *Medical Decision Making*, 21, 380-388.
- WRAY, L. D., & STONE, E. R. (2005). The role of self-esteem and anxiety in decision making for self versus others in relationships. *Journal of Behavioral Decision Making*, 18, 125-144.
- VON WINTERFELDT, D., & EDWARDS, W. (1986). *Decision analysis and behavioral research*. New York: Cambridge University Press.
- YATES, J. F. (1990). *Judgment and Decision Making*. New York: Wiley.
- ZIKMUND-FISHER, B. J. (2004). De-escalation after repeated negative feedback: Emergent expectations of failure. *Journal of Behavioral Decision Making*, 17, 365-379.

Annex A:

Baseline state emotion measure

Please describe your current feelings (that is, how you have been feeling today)
Use the scale below to describe how you feel today. Circle a number on the scale from 0 (you did not feel even the slightest bit of the emotion) to 8 (you did feel the emotion more than you ever felt it before in your life).

1. I feel worried today

0	1	2	3	4	5	6	7	8
Do not feel the emotion the slightest bit								Feel the emotion even more than ever before

2. I feel sad today

0	1	2	3	4	5	6	7	8
Do not feel the emotion the slightest bit								Feel the emotion even more than ever before

3. I feel happy today

0	1	2	3	4	5	6	7	8
Do not feel the emotion the slightest bit								Feel the emotion even more than ever before

4. I feel fearful today

0	1	2	3	4	5	6	7	8
Do not feel the emotion the slightest bit								Feel the emotion even more than ever before

5. I feel enraged today

0	1	2	3	4	5	6	7	8
Do not feel the emotion the slightest bit								Feel the emotion even more than ever before

6. I feel frightened today

0	1	2	3	4	5	6	7	8
Do not feel the emotion the slightest bit								Feel the emotion even more than ever before

7. I feel mad today

0	1	2	3	4	5	6	7	8
Do not feel the emotion the slightest bit								Feel the emotion even more than ever before

8. I feel disgusted today

0	1	2	3	4	5	6	7	8
Do not feel the emotion the slightest bit								Feel the emotion even more than ever before

9. I feel sad today

0	1	2	3	4	5	6	7	8
Do not feel the emotion the slightest bit								Feel the emotion even more than ever before

10. I feel terrified today

0	1	2	3	4	5	6	7	8
Do not feel the emotion the slightest bit								Feel the emotion even more than ever before

11. I feel amused today

0	1	2	3	4	5	6	7	8
Do not feel the emotion the slightest bit								Feel the emotion even more than ever before

12. I feel furious today

0	1	2	3	4	5	6	7	8
Do not feel the emotion the slightest bit								Feel the emotion even more than ever before

13. I feel angry today

0	1	2	3	4	5	6	7	8
Do not feel the emotion the slightest bit								Feel the emotion even more than ever before

Annex B:

Trait emotion measure

This scale consists of a number of statements that people have used to describe themselves. Read each statement and then circle the appropriate value to the right of the statement to indicate how you generally feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe how you generally feel.

	Almost never	Some- times	Often	Almost always
1. I feel safe	1	2	3	4
2. I am afraid	1	2	3	4
3. I am content	1	2	3	4
4. I feel that life is unpredictable	1	2	3	4
5. I feel uncertain about major aspects of my life	1	2	3	4
6. I worry too much over something that really doesn't matter	1	2	3	4
7. I have a sense that important things in life are under one's control	1	2	3	4
8. I feel secure	1	2	3	4
9. I feel nervous and anxious	1	2	3	4
10. I am a steady person	1	2	3	4
11. I get in a state of tension or turmoil as I think over my recent concerns and interests	1	2	3	4
12. I am "calm, cool, and collected"	1	2	3	4
13. When I don't like someone, I feel certain about it	1	2	3	4
14. I am mad at someone or something	1	2	3	4
15. I find myself feeling angry	1	2	3	4
16. I am frustrated by other people	1	2	3	4
17. I expect to beat others in competition	1	2	3	4
18. A lot of people annoy me	1	2	3	4
19. I get mad easily	1	2	3	4
20. I get enraged	1	2	3	4
21. Other drivers on the road infuriate me	1	2	3	4
22. I'd like to tell people how much they frustrate me	1	2	3	4
23. I am as cheerful as most people	1	2	3	4
24. I feel a need to push those responsible for terrorist attacks	1	2	3	4
25. I feel a desire to hurt the people who commit terrorist attacks	1	2	3	4
26. War is the only possible response to terrorist attacks	1	2	3	4
27. We need to wipe out those responsible for terrorist attacks	1	2	3	4

Annex C:

Dirty bomb scenario

Dirty bomb

Imagine that, about one hour ago, a truck bomb exploded in your area. It is suspected to be an act of terrorism. At least a dozen people have been reported dead and more than thirty others have already been taken to hospitals to be treated for injuries.

The truck bomb was a “dirty bomb” meaning it was laced with radioactive materials that were dispersed by the blast. The explosion created a cloud of radioactive dust that rose hundreds of feet into the air and was carried downwind in an easterly direction. Radioactive dust within this cloud can expose people to radiation, both while they are in the air and after the dust has fallen back to the ground. By now, one hour after the blast, most of this radioactive dust has settled onto the ground. Although the greatest concentration of radioactivity is found within a block or two of the point of the explosion, hazardous levels of contamination may occur as far as 5 kilometers (or 3 miles) downwind.

Health officials do not expect levels of radiological contamination to be high enough to cause radiation sickness, except perhaps among people who were within a few hundred meters (or yards) of the explosion location. Beyond that distance, the main health effect of exposure to the radioactive dust spread by this explosion is an increased risk of cancer. Exposure to the radioactive dust can occur in three ways. First, radiation can come from dust that is lying on the ground or on other surfaces. Second, radiation exposure can come from dust that settles on peoples’ skin, hair, or clothing. Finally, if radioactive dust is inhaled, they can lodge in the lungs and expose lung tissue to radiation. Cancer risk can be reduced by reducing all three types of radiation exposure.

Until authorities are able to identify where the areas of significant radiation are located, citizens within 5 kilometers (or 3 miles) of the explosion are advised by government health officials to go indoors and remain indoors. The walls of buildings will shield people from radiation emitted by radioactive dust on the ground. You are advised that if you have spent any time out of doors since the time of the explosion, you should remove your outer layer of clothing because it might be contaminated with radioactive dust. In addition, those who were outdoors should wash hair and exposed skin to flush away any radioactive dust that might have settled on them.

Imagine that you are within 5 kilometers (or 3 miles) of the explosion. You are advised by the officials to immediately seek shelter in the safest room in the building, whether you are at home or at your place of work. The safest room is the one that is best protected from radiation coming in from outside. This would be against an earth-backed basement wall or, if in a tall building, anywhere on the upper floors, but not on the three top floors.

You are also advised to make sure that it is hard for radiation dust to get into your “safest room” by closing doors and windows, and by shutting off air conditioning and closing vents. When you go into the “safest room,” you should bring food, water and other necessities with you. Once you are in your “safest room,” you are advised to stay there as much as is possible to minimize your radiation exposure. You will be notified through broadcast announcements when it is safe to leave your shelter area. Citizens are strongly advised not to attempt to flee the area because this is likely to result in even greater radiation exposure than remaining indoors. You will be given more information as soon as it becomes available.

Annex D:

Bird flu scenario

Bird flu

Imagine that H5N1, the virus that causes bird flu, has become transmissible from human to human. Hundreds of cases have already been identified across North America, including your city. Health officials expect that the outbreak will last a few months. Within those few months, as many as [11,000,000 people in Canada / 100,000,000 people in the United States] are expected to get sick with this human form of bird flu. Among them, as many as [660,000 / 6,000,000] people are expected to die. To date, vaccines and anti-viral medicines (like Tamiflu) are not yet available in sufficient quantities to stop the pandemic.

Health officials expect that you can get flu from inhaling tiny droplets with flu virus in them. When an infected person coughs, sneezes, or even talks, these droplets move through the air. Droplets can also be on their hands, after they touch their nose or mouth. Droplets can then be passed on to you when you shake their hands or touch something that they have touched, like eating utensils, door knobs, or elevator buttons. You can then infect yourself by touching your nose, mouth, or eyes.

Health officials have indicated that wearing masks can protect you from droplets, if you use the right masks in the right way. A good mask has a snug fit and is made of materials that keep droplets from getting through it. Experts disagree whether cloth masks will provide any protection. N-95 surgical masks are recommended for protection against flu.

To protect yourself, you have to wear an N-95 surgical mask every time you are around other people (including loved ones). During a pandemic, anyone might be infected, even if they seem healthy.

Wearing masks can be a challenge. It can make it hard to care for sick loved ones. If you are sick yourself, it can be hard to wear a mask. For example, you can not eat, drink, use an inhaler, or smoke while wearing one. If you do take it off, you are strongly advised to avoid going near other people or touch anything that might be contaminated.

Health officials recommend that you use a clean N-95 surgical mask every time. If you put on a contaminated mask, you can infect yourself. You also have to be careful not to infect yourself when taking your mask off. That means taking the mask off without touching its outside, and then carefully washing your hands. Discard used masks so that no one will touch them.

There may be too few masks, because the government has not stockpiled enough. In that case, you will have to try to buy your own masks. Price may go up, perhaps limiting how many you can afford. You may also have less money, if a pandemic messes up the economy and affects your job. If you are worried about a pandemic, it may be better to buy masks before there is an outbreak – if you can afford to.

Annex E:

Questions about the dirty bomb scenario

For each question, please circle one of the numbers on the scale to indicate your answer.

1. How well did you understand the information you were just given about how to protect yourself from radioactive dust? (*comprehension*)

1 2 3 4 5 6 7
Not at all Very much

2. How hard or easy would it be for you to remember how to protect yourself from radioactive dust? (*comprehension*)

1 2 3 4 5 6 7
Very hard Very easy

For the next questions, imagine that a dirty bomb exploded within a 5 kilometer (or 3 mile) distance from your home and there is radioactive dust in the air. You are recommended to seek shelter in the safest room for the first 24 hours after the explosion.

3. How much do you trust that the government would provide you with honest messages if there is radioactive dust in the air? (*trust*)

1 2 3 4 5 6 7
Not at all Very much

4. How much do you trust that the government would ensure that you are given frequent updates regarding your situation? (*trust*)

1 2 3 4 5 6 7
Not at all Very much

5. How hard or easy would it be for you to find the safest room to shelter in? (*feasibility*)

1 2 3 4 5 6 7
Very hard Very easy

6. How hard or easy would it be for you to shelter in the safest room for the first 24 hours after the explosion? (*feasibility*)

1 2 3 4 5 6 7
Very hard Very easy

7. How hard or easy would it be for you to cope psychologically with the consequences of this dirty bomb attack? (*resilience*)

1 2 3 4 5 6 7
Very hard Very easy

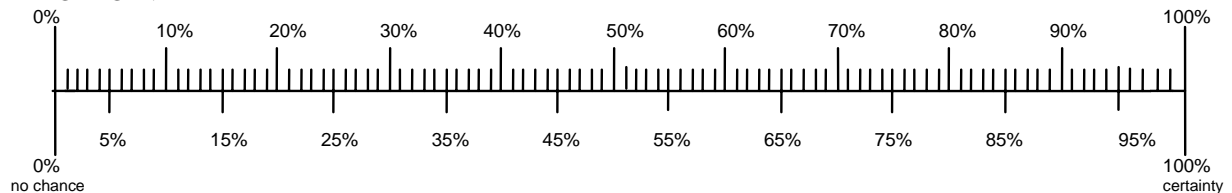
8. How hard or easy would it be for you to cope physically with the consequences of this dirty bomb attack? (*resilience*)

1	2	3	4	5	6	7
Very hard						Very easy

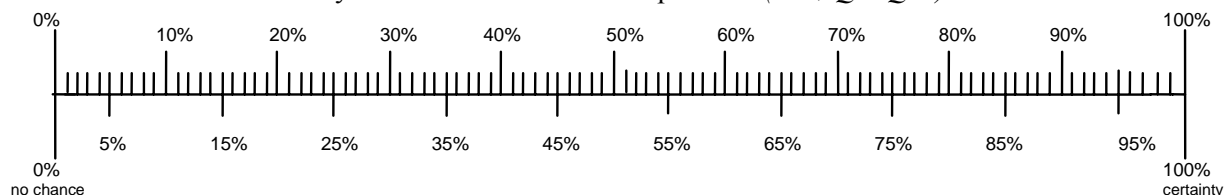
Please continue to imagine that a dirty bomb exploded within a 5 kilometer (or 3 mile) distance from your home and there is radioactive dust in the air. You are recommended to seek shelter in the safest room for the first 24 hours after the explosion.

The following questions ask, in detail, about the chance that different events would happen under these circumstances. For each of the next questions, please make a mark on the scale to indicate your answer.

9. What is the chance that you would be hurt in the explosion and die from your wounds? (*risk*; $Q9 \leq Q10$)

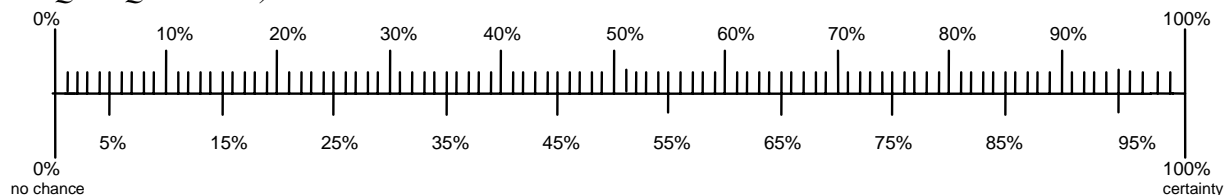


10. What is the chance that you would be hurt in the explosion? (*risk*; $Q9 \leq Q10$)

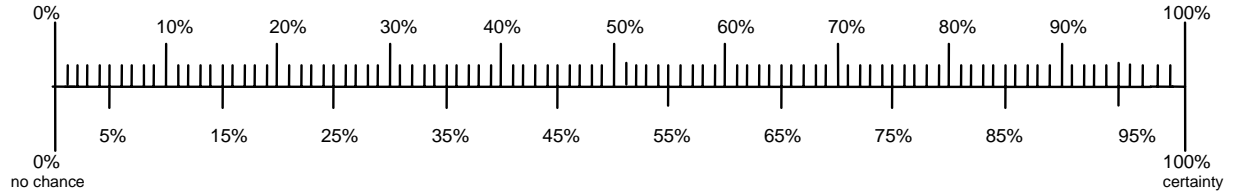


For the following questions, imagine that you are at home when the dirty bomb explodes in your area.

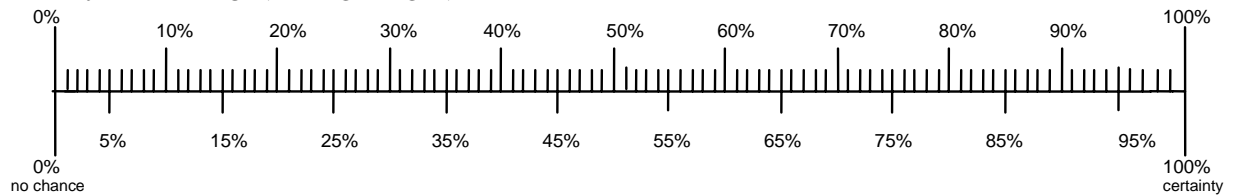
11. If you were at home when the dirty bomb exploded, what is the chance that you wouldn't have sheltered inside for the first 24 hours after the explosion? (*compliance, reverse-coded; $Q11+Q15=100\%$*)



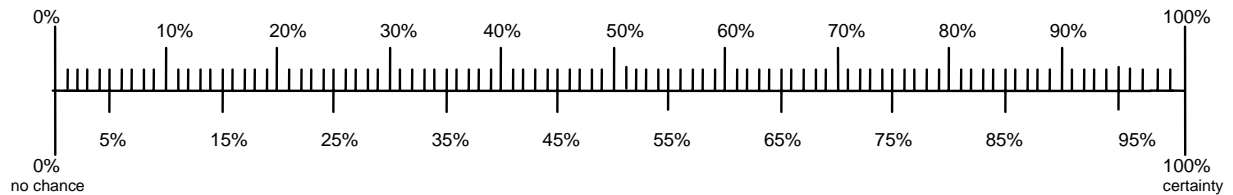
12. What is the chance that you would have enough food at home if you had to seek shelter there for 24 hours? (*stockpile; Q16≤Q12*)



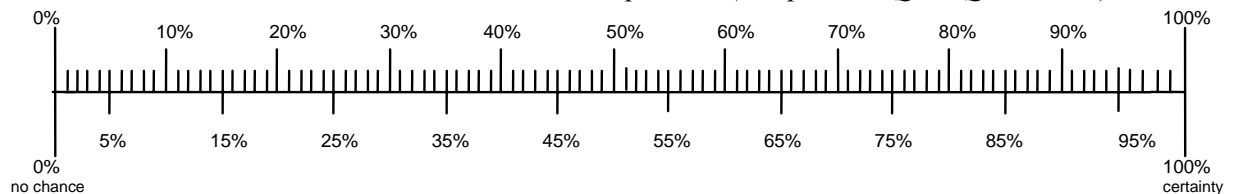
13. What is the chance that you would develop cancer some time later in your life from the radioactive dust spread by the dirty bomb, if you had sought shelter in the safest room in your home for the first 24 hours after the explosion without removing the contaminated outer layer of your clothing? (*risk; Q13≤Q14*)



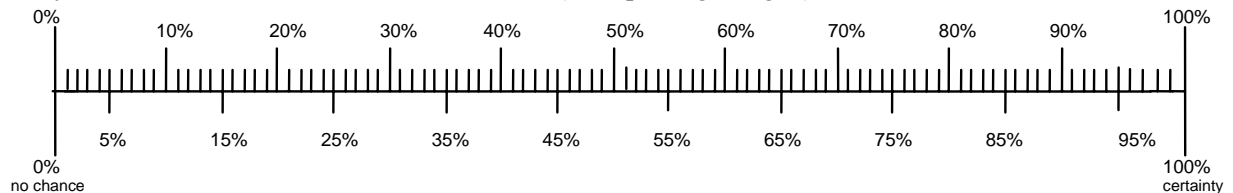
14. What is the chance that you would develop cancer some time later in your life from the radioactive dust spread by the dirty bomb, if you had removed the contaminated outer layer of your clothing before seeking shelter in the safest room in your home for the first 24 hours after the explosion? (*risk; Q13≤Q14*)



15. If you were at home when the dirty bomb exploded, what is the chance that you would have sheltered inside for the first 24 hours after the explosion? (*compliance; Q11+Q15=100%*)

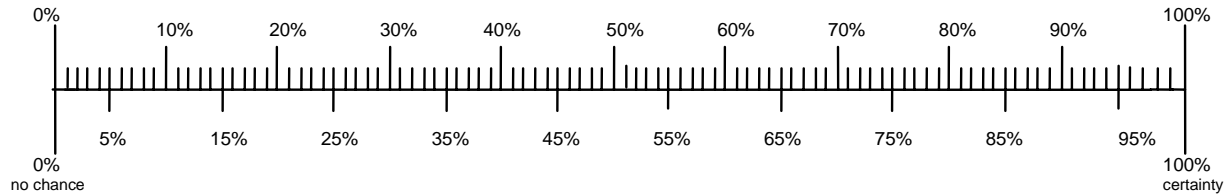


16. What is the chance that you would have enough food and other essential supplies at home if you had to seek shelter there for 24 hours? (*stockpile; Q16≤Q12*)

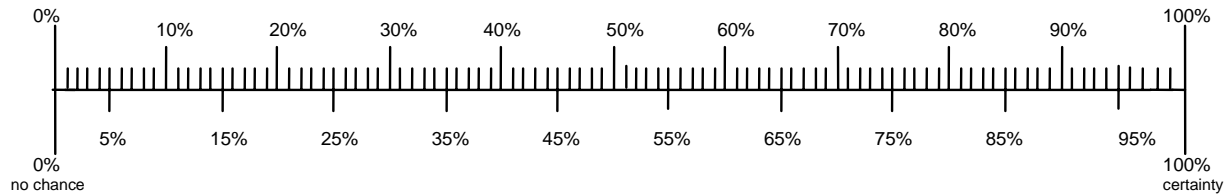


For the following questions, imagine that you are at work when the dirty bomb explodes in your area.

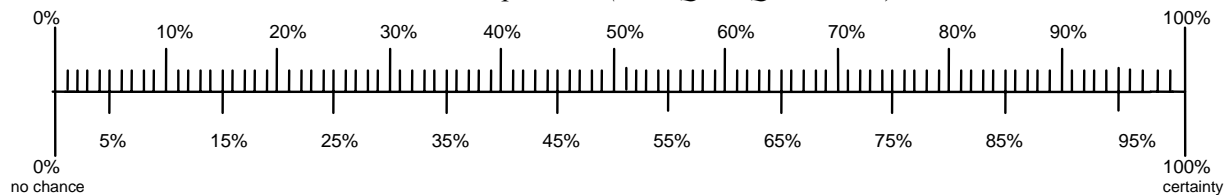
17. If you were at work when the dirty bomb exploded, what is the chance that you wouldn't remain sheltered inside for the first 24 hours after the explosion? (*compliance, reverse-coded; $Q17+Q23=100\%$*)



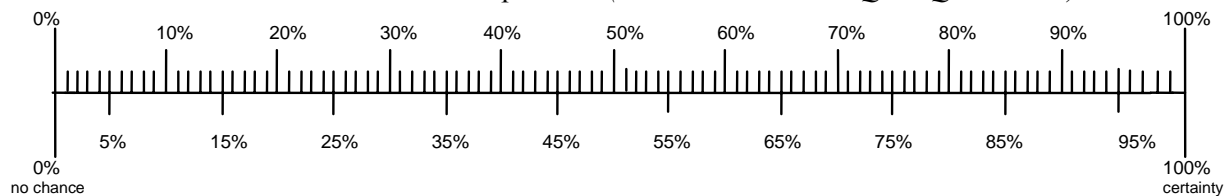
18. What is the chance that you would have enough food at work if you had to seek shelter there for 24 hours? (*stockpile; $Q24 \leq Q18$*)



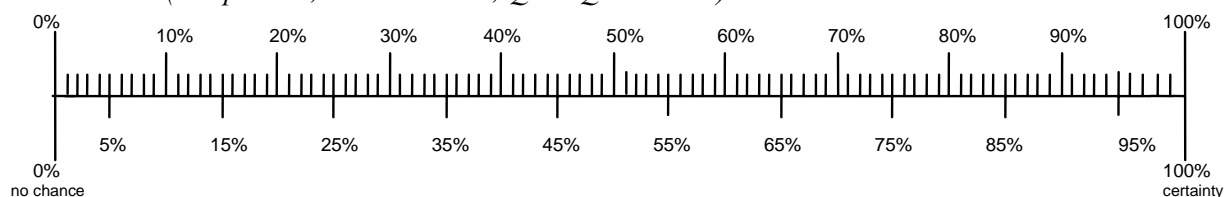
19. What is the chance that you would develop cancer some time later in your life from the radioactive dust spread by the dirty bomb, if you had sought shelter in the safest room at work for the first 24 hours after the explosion? (*risk; $Q19+Q20=100\%$*)



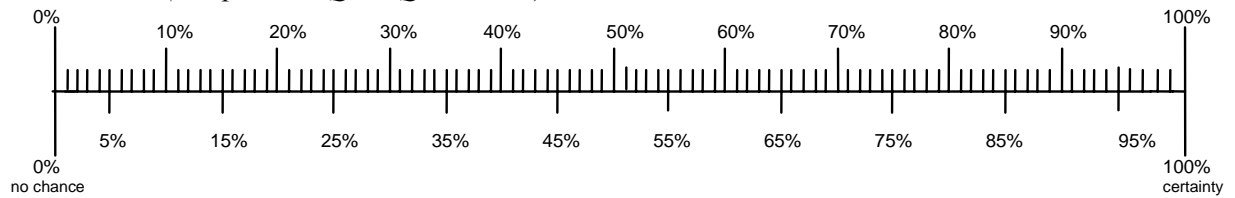
20. What is the chance that you wouldn't develop cancer some time later in your life from the radioactive dust spread by the dirty bomb, if you had sought shelter in the safest room at work for the first 24 hours after the explosion? (*risk, reverse-coded; $Q19+Q20=100\%$*)



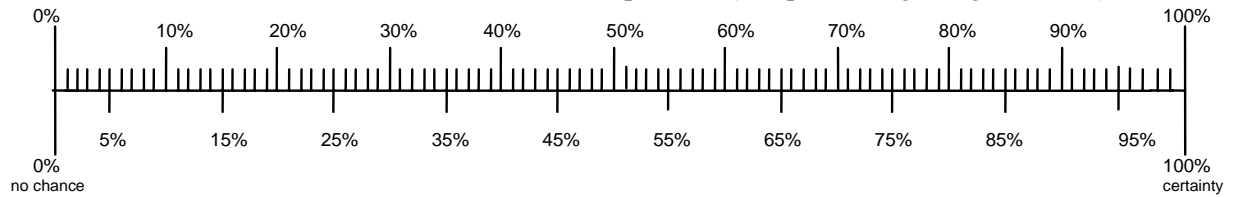
21. If you were at work when the dirty bomb exploded, what is the chance that you would flee the area? (*compliance, reverse-coded; $Q21+Q22=100\%$*)



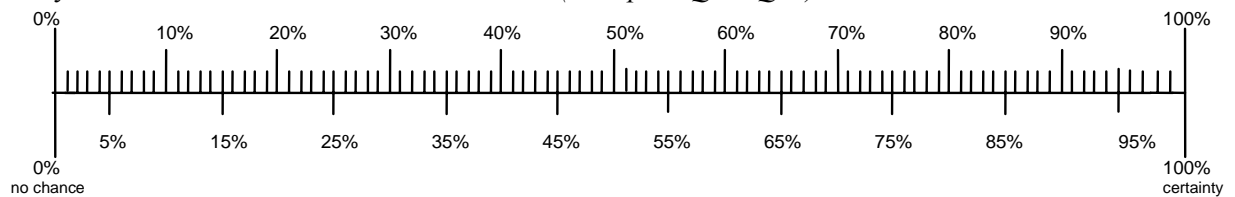
22. If you were at work when the dirty bomb exploded, what is the chance that you wouldn't flee the area? (*compliance; $Q21+Q22=100\%$*)



23. If you were at work when the dirty bomb exploded, what is the chance that you would remain sheltered inside for the first 24 hours after the explosion? (*compliance; $Q17+Q23=100\%$*)



24. What is the chance that you would have enough food and other essential supplies at work, if you had to seek shelter there for 24 hours? (*stockpile; $Q24 \leq Q18$*)



Annex F:

Questions about the bird flu scenario

For each question, please circle one of the numbers on the scale to indicate your answer.

1. How well did you understand the information you were just given about how to use N-95 surgical masks to protect yourself from bird flu? (*comprehension*)

1 2 3 4 5 6 7
Not at all Very much

For the next questions, imagine that there is human-to-human transmission of bird flu, and hundreds of cases have been identified across North America, including in your city. The outbreak is expected to last a few months.

2. How hard or easy would it be for you to remember what you just read about how to use N-95 surgical masks? (*comprehension*)

1 2 3 4 5 6 7
Very hard Very easy

3. How much do you trust the government to provide you with honest messages? (*trust*)

1 2 3 4 5 6 7
Not at all Very much

4. How much do you trust the government to provide you with enough N-95 surgical masks? (*trust*)

1 2 3 4 5 6 7
Not at all Very much

5. How hard or easy would it be for you to wear an N-95 surgical mask every time you are around other people (including loved ones)? (*feasibility*)

1 2 3 4 5 6 7
Very hard Very easy

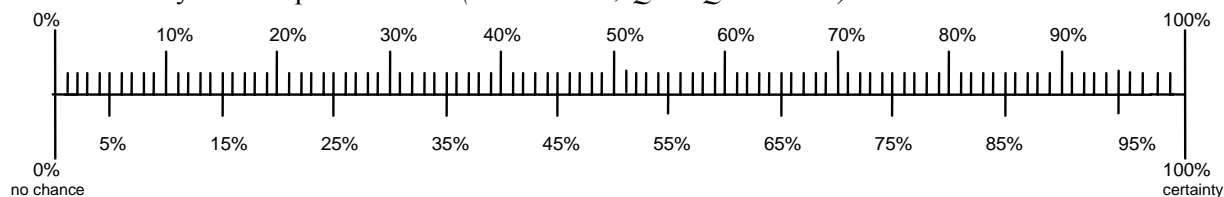
6. How hard or easy would it be for you to wear an N-95 surgical mask when taking care of loved ones who are sick? (*feasibility*)

1 2 3 4 5 6 7
Very hard Very easy

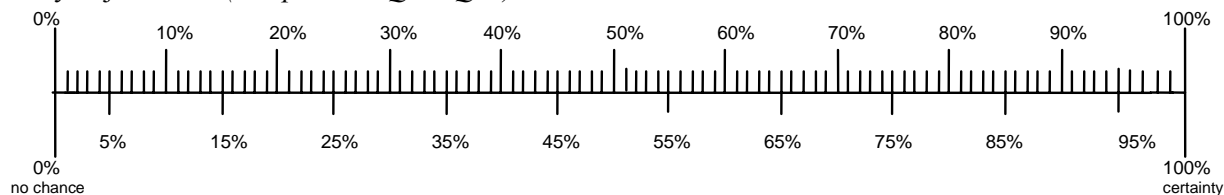
7. How hard or easy would it be for you to cope psychologically with the consequences of a human-to-human outbreak of bird flu in this country? (*resilience*)

1 2 3 4 5 6 7
Very hard Very easy

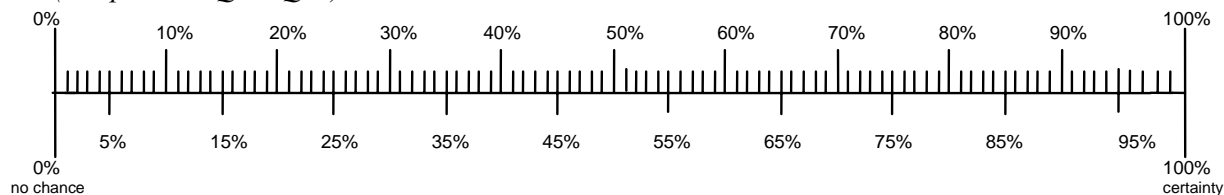
13. What is the chance that you would stop going to work, if you did not have enough N-95 surgical masks for your own personal use? (*absenteeism; $Q13+Q25=100\%$*)



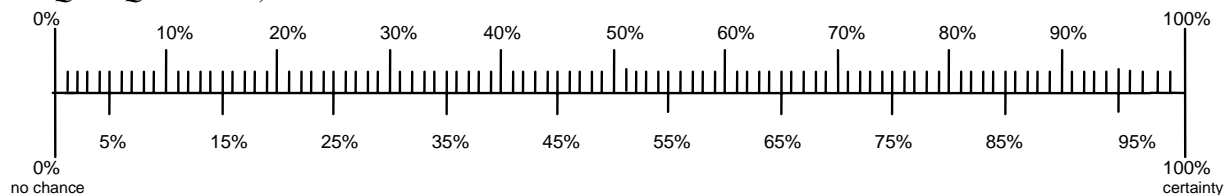
14. What is the chance that you would use N-95 surgical masks exactly as recommended in the message you just read? (*compliance; $Q14 \leq Q15$*)



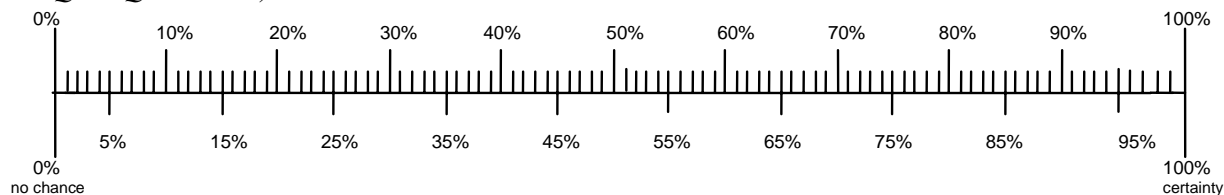
15. What is the chance that you would use a new N-95 surgical mask every time you wore a mask? (*compliance; $Q14 \leq Q15$*)



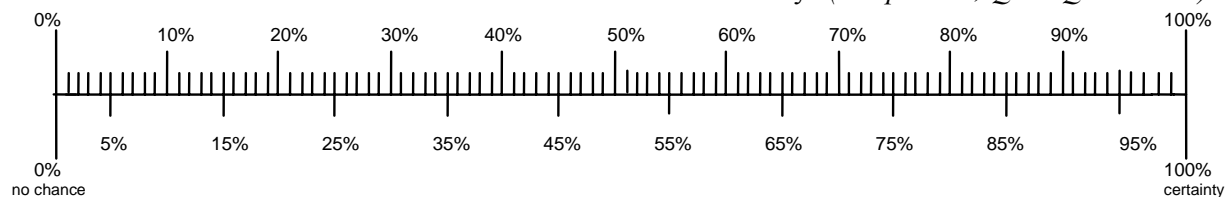
16. What is the chance that you would have enough N-95 surgical masks for your own personal use by the time there is human-to-human transmission of bird flu in this country? (*stockpile; $Q16+Q17=100\%$*)



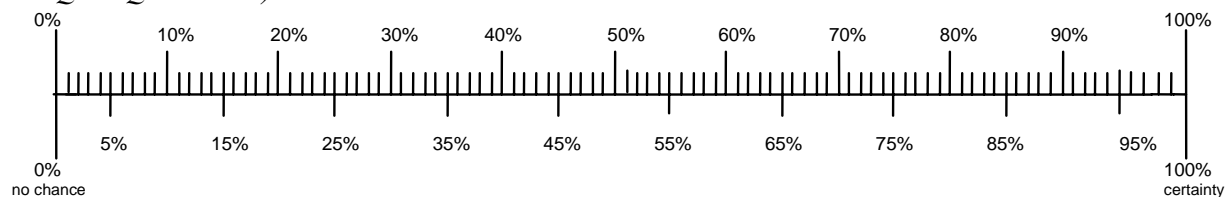
17. What is the chance that you wouldn't have enough N-95 surgical masks for your own personal use by the time there is human-to-human transmission of bird flu in this country? (*stockpile, reverse-coded; $Q16+Q17=100\%$*)



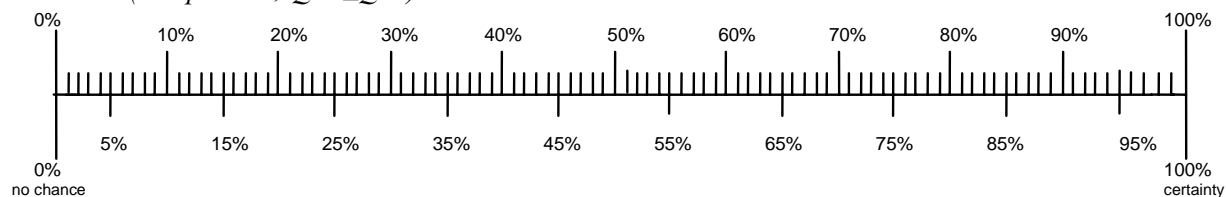
18. What is the chance that you would buy any N-95 surgical masks for your own personal use before there is human-to-human transmission of bird flu in this country? (*compliance; $Q18+Q19=100\%$*)



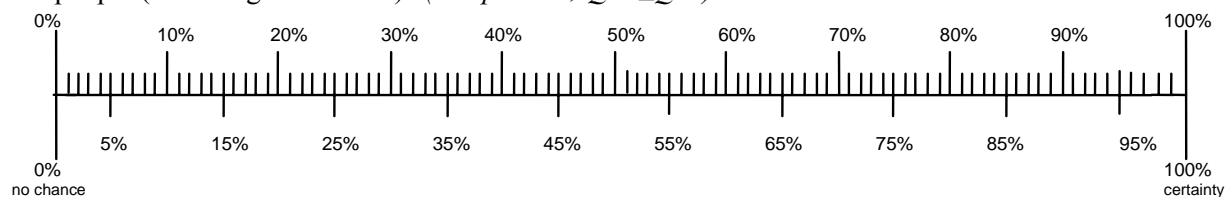
19. What is the chance that you wouldn't buy any N-95 surgical masks for your own personal use before there is human-to-human transmission of bird flu in this country? (*compliance, reverse-coded; $Q18+Q19=100\%$*)



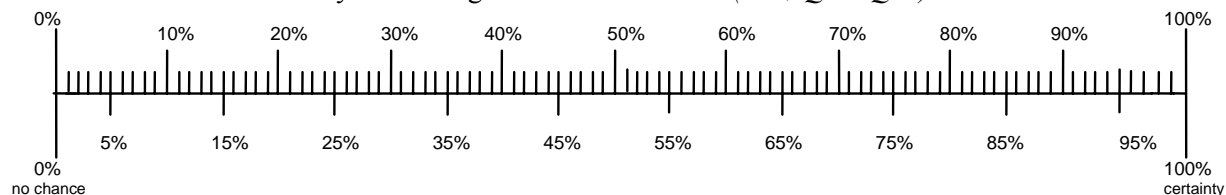
20. What is the chance that you would always wear an N-95 surgical mask while being around loved ones? (*compliance; $Q21 \leq Q20$*)



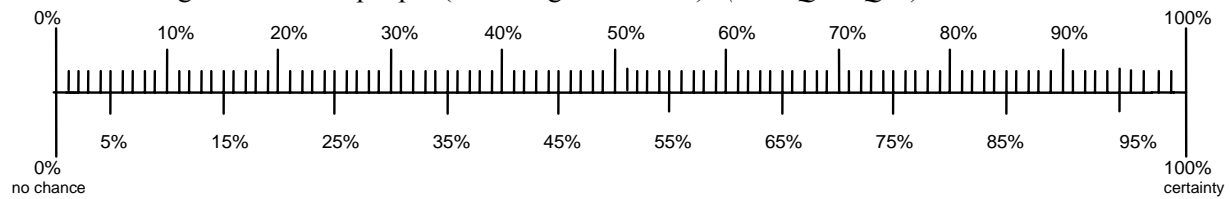
21. What is the chance that you would always wear an N-95 surgical mask while being around other people (including loved ones)? (*compliance; $Q21 \leq Q20$*)



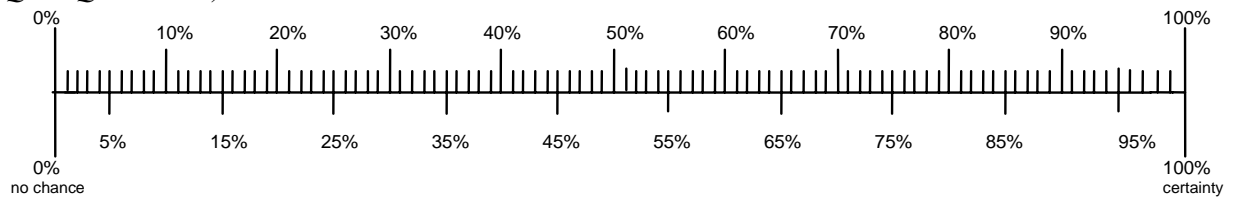
22. What is the chance that you would get sick with bird flu? (*risk; $Q10 \leq Q22$*)



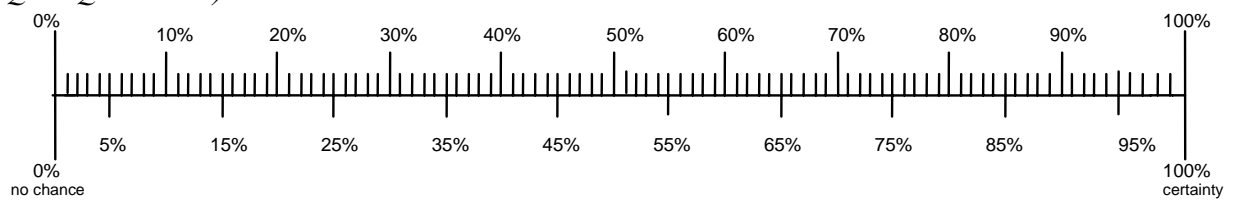
23. What is the chance that you would get sick with bird flu if you never wore an N-95 surgical mask while being around other people (including loved ones)? (*risk; $Q11 \leq Q23$*)



24. What is the chance that you wouldn't get sick with bird flu if you always wore an N-95 surgical mask while being around other people (including loved ones)? (*risk, reverse-coded; $Q12 + Q24 = 100\%$*)



25. What is the chance that you would continue to go to work, even if you did not have enough N-95 surgical masks for your own personal use? (*absenteeism, reverse-coded; $Q13 + Q25 = 100\%$*)



Annex G:

Project 2 survey (high-risk condition)

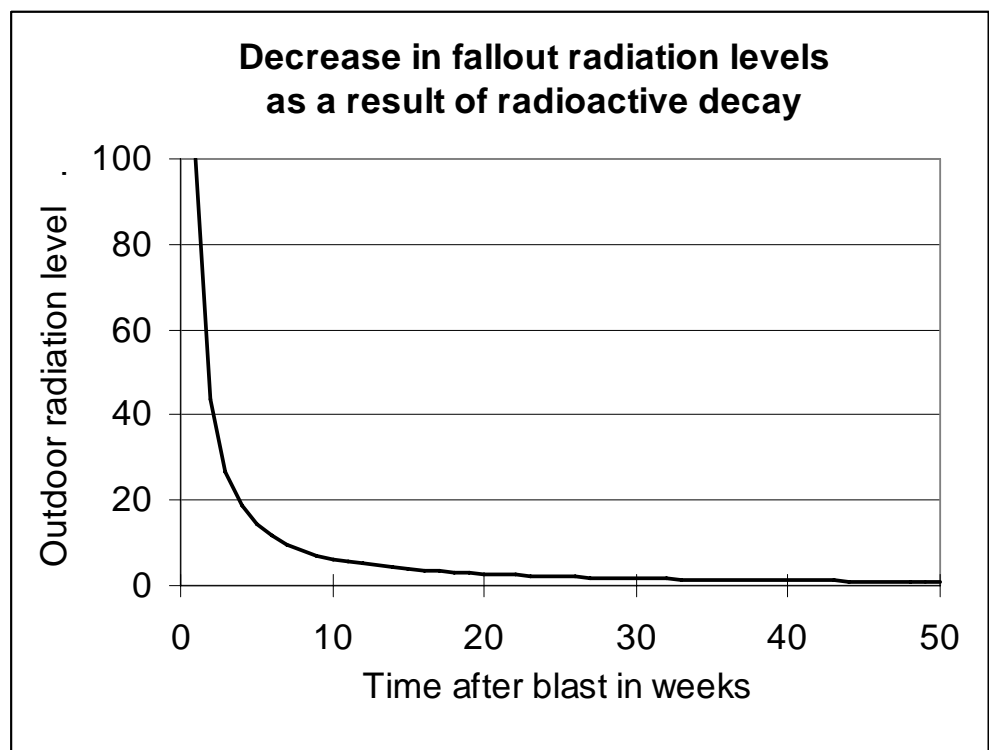
Nuclear bomb attack

Imagine that terrorists set off a nuclear bomb somewhere in our country. The explosion flattened buildings within approximately 2 kilometers (or 1 mile) of the blast. The explosion blew radioactive dust high into the air, which was then spread by the wind. Downwind, it eventually settled to the ground. This radioactive dust, known as “fallout,” gives off harmful radiation.

Exposure to very high levels of fallout radiation can kill you within days or weeks. Exposure to low levels of fallout radiation increases your risk of cancer and shortening your life expectancy.

Over time, fallout gives off less radiation. Figure 1 shows how radiation levels decrease over time. Fifty weeks after the explosion, radiation levels are only 1/100 as strong as they were 1 week after the explosion. However, even those lower radiation levels still pose some cancer risk.

Figure 1



Another way to think about the cancer risk from radiation is in terms of average life expectancy lost. If the risk were very small, returning residents might, on average, expect to live one day less. That is another way of saying that scientists expect very few returning residents to get cancer from the radiation, and even those to occur very late in their lives. If the cancer risk were 365 times bigger, the returning resident would, on average, expect to live one year less than they would have without moving back. Because lost life expectancy is an average, some people will get cancer from radiation exposure and lose a lot of days from their lives, while nothing at all will happen to the others. And some people might die of other causes unrelated to the blast (such as a car accident or a heart attack), before they ever develop cancer.

Imagine that government authorities have ordered a total evacuation of neighborhoods contaminated with fallout. Evacuees are advised to stay outside the fallout-contaminated zone until radiation levels to decrease. The longer people stay away, the lower their cancer risk and the lower their lost life expectancy.

Now we'd like you to think about what government policy should be in this situation.

1. The government should only allow people to move back to their homes when the lost life expectancy from radiation exposure is approximately at the following level:
 - ☐ 1 day
 - ☐ 1 week
 - ☐ 1 month
 - ☐ 3 months
 - ☐ 6 months
 - ☐ 1 year
 - ☐ 2 years
 - ☐ 4 years
 - ☐ more than 4 years
 - ☐ people should be allowed to return to their homes, if they want to, no matter how high the risk level – as long as they know what the risk is.

Please explain your answer:

2. Some people think that the government should provide free housing to people evacuated because of a terrorist nuclear explosion. How long do you think the government should provide free housing to people who have evacuated because of a terrorist nuclear explosion?

- ☐ 1 day
- ☐ 1 week
- ☐ 1 month
- ☐ 3 months
- ☐ 6 months
- ☐ 1 year
- ☐ 2 years
- ☐ 4 years
- ☐ more than 4 years
- ☐ The government should not provide free housing at all

Please explain your answer:

Now imagine that the nuclear blast occurred in your area and that you were at home at the time, along with everyone else in your household. Your home doesn't have any blast damage, but is contaminated by fallout. You follow official instructions and evacuate your neighborhood. You find free temporary housing in an emergency trailer community paid for by the government, which also gives some money to evacuees who cannot work.

Imagine that the government decides that people can go back whenever they want. You and your household must now decide how long to stay in the temporary housing. Figure 2 shows the cancer risk that a person would assume by moving back at various times, in terms of life expectancy lost. For example, moving back after a week means losing about 1000 days life expectancy. Moving back after 6 months means losing 400 days of life expectancy. Waiting 20 years means losing a few days of life expectancy.

Figure 2

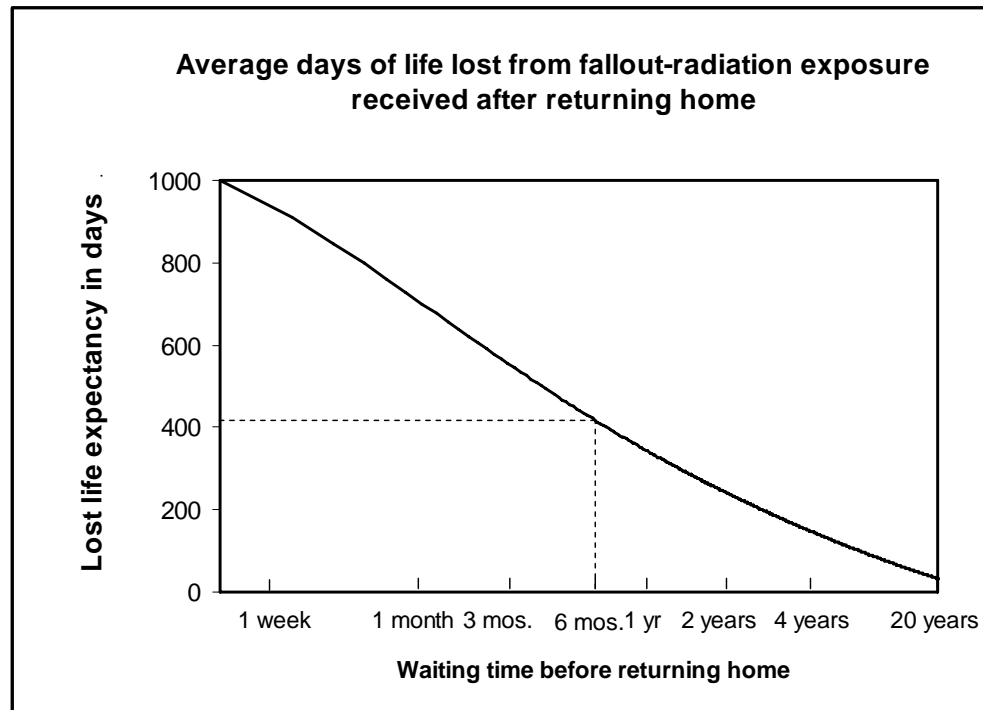


Figure 2

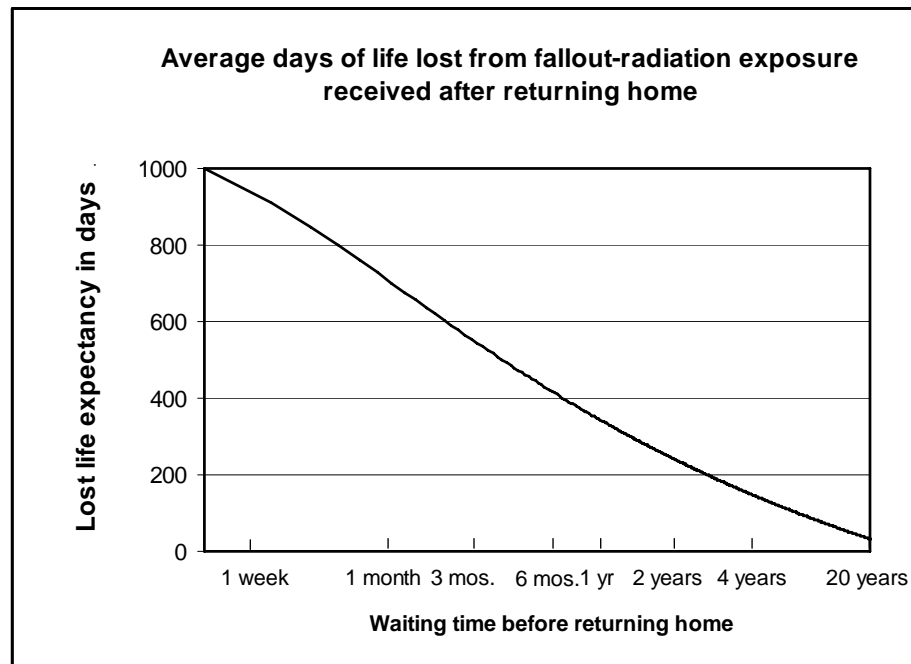
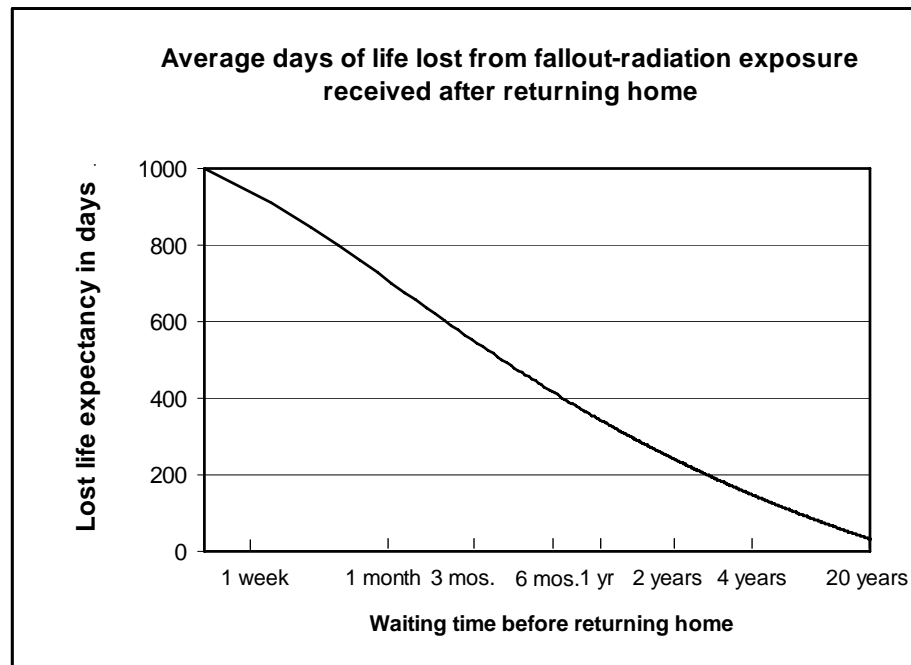


Figure 2 is the same as the figure you just saw on the previous page. The following questions ask about the details presented in Figure 2.

3. According to Figure 2, how many days of lost life expectancy, on average, would a person lose ...

... by moving back home <u>1 week</u> after the blast?	Approximately _____ days
... by moving back home <u>3 months</u> after the blast?	Approximately _____ days
... by moving back home <u>1 year</u> after the blast?	Approximately _____ days
... by moving back home <u>4 years</u> after the blast?	Approximately _____ days

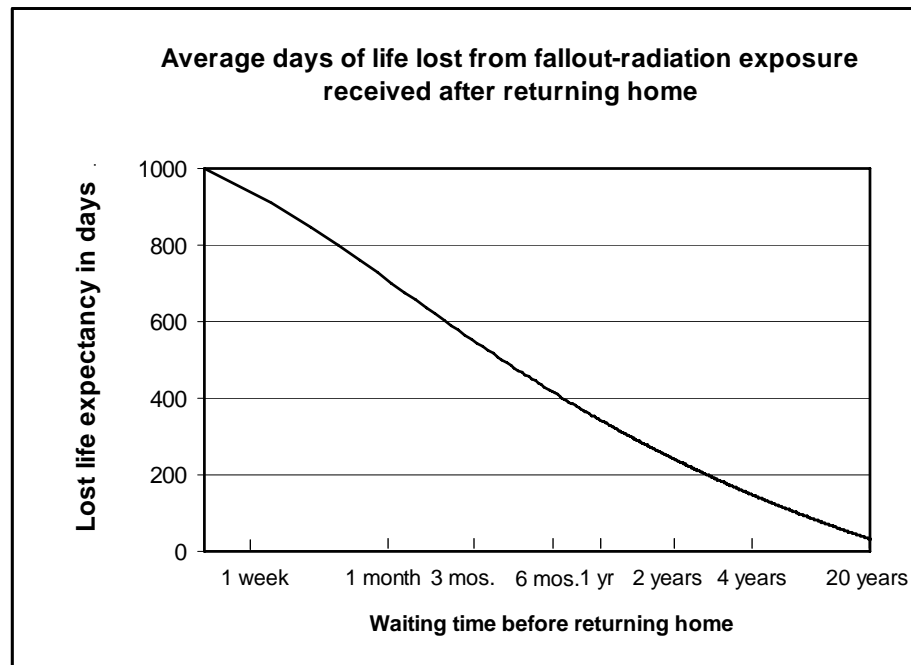
Figure 2



4. Now assume that the government allows you to move back whenever you want, but is willing to give you free temporary housing indefinitely. Assume that, if you go back, you will find the usual community services, such as schools, utilities, and trash pickup. How long would you wait until returning to your neighborhood?
- a. I would return after:
- ☐ 1 day
 - ☐ 1 week
 - ☐ 1 month
 - ☐ 3 months
 - ☐ 6 months
 - ☐ 1 year
 - ☐ 2 years
 - ☐ 4 years
 - ☐ more than 4 years
 - ☐ I would never return
- b. According to Figure 2, the time period I indicated above means having an average life expectancy lost of approximately _____ days

Please explain your answer:

Figure 2



5. Now assume that the government has given you no support for temporary housing but allows you to move back whenever you want. Assume that the usual community services, such as schools, utilities, and trash pickup have resumed in your neighborhood. Given these assumptions and the information in Figure 2, how long would you wait until returning to your neighborhood?
- a. I would return after:
- ☐ 1 day
 - ☐ 1 week
 - ☐ 1 month
 - ☐ 3 months
 - ☐ 6 months
 - ☐ 1 year
 - ☐ 2 years
 - ☐ 4 years
 - ☐ more than 4 years
 - ☐ I would never return
- b. According to Figure 2, the time period I indicated above means having an average life expectancy lost of approximately _____ days

Please explain your answer:

6. How important is each factor, in thinking about when, and if, you would move back (assuming that the government gives you free temporary housing)?

a. The cancer risk from the radioactive fallout

1	2	3	4	5	6	7
Not important						Very important

b. Your financial situation

1	2	3	4	5	6	7
Not important						Very important

c. The quality of life in temporary housing

1	2	3	4	5	6	7
Not important						Very important

d. Whether you miss your home and your neighborhood

1	2	3	4	5	6	7
Not important						Very important

e. Whether government authorities say it's safe to move back

1	2	3	4	5	6	7
Not important						Very important

f. The quality of your health insurance plan (in case you develop cancer)

1	2	3	4	5	6	7
Not important						Very important

g. Your current health and that of those living with you

1	2	3	4	5	6	7
Not important						Very important

h. Whether you are given a monitor to keep track of the amount of radiation to which you have been exposed

1	2	3	4	5	6	7
Not important						Very important

Please write down other factors relevant to your decision about moving back, and rate the importance for each.

h. (describe) _____

1	2	3	4	5	6	7
Not important						Very important

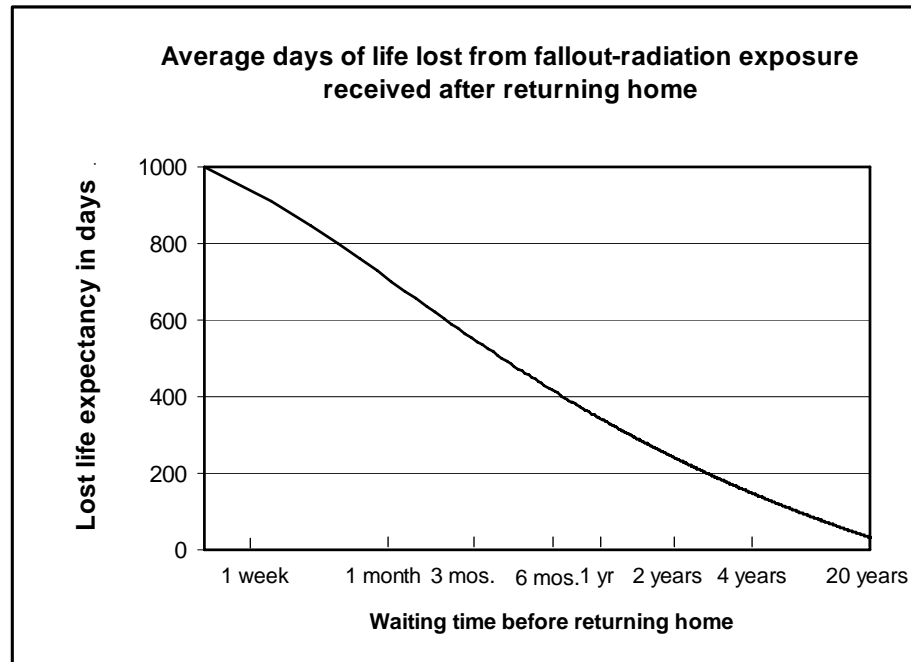
i. (describe) _____

1	2	3	4	5	6	7
Not important						Very important

j. (describe) _____

1	2	3	4	5	6	7
Not important						Very important

Figure 2



7. Now assume that your neighborhood is fine, but that you have friends who have evacuated from their fallout-contaminated neighborhood. The government allows your friends to move back whenever they want, but is willing to give them free temporary housing indefinitely. Assume that, if they move back, they will find the usual community services, such as schools, utilities, and trash pickup have resumed in their neighborhood. How long would you recommend that your friends wait until returning to home?

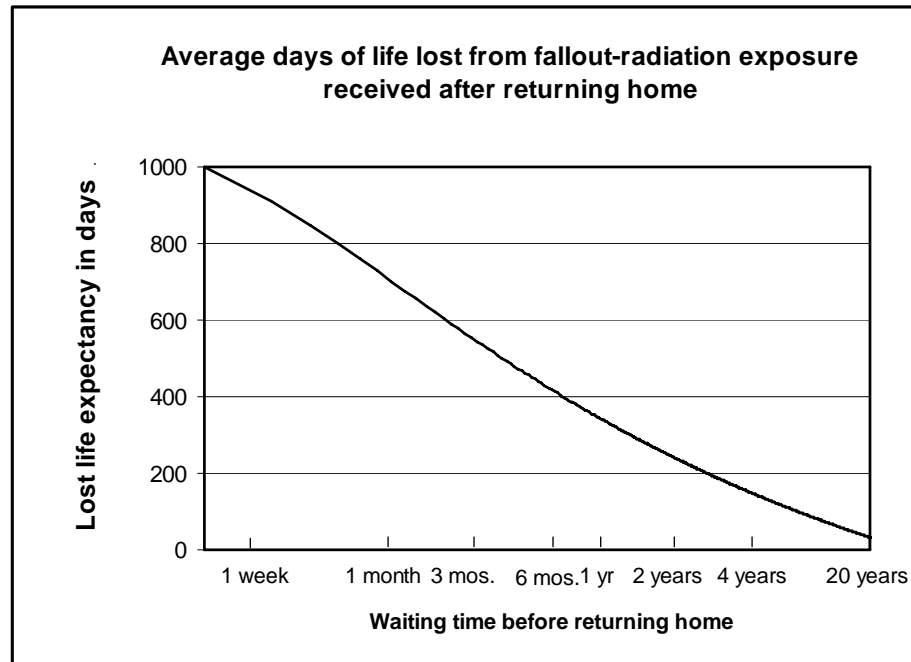
a. I would recommend that my friends return after:

- ☐ 1 day
- ☐ 1 week
- ☐ 1 month
- ☐ 3 months
- ☐ 6 months
- ☐ 1 year
- ☐ 2 years
- ☐ 4 years
- ☐ more than 4 years
- ☐ I would recommend that they never return

b. According to Figure 2, the time period I indicated above means having an average life expectancy lost of approximately _____ days

Please explain your answer:

Figure 2



8. Now assume that the government has given your friends no support for temporary housing but allows them to move back whenever they want. Assume that the usual community services, such as schools, utilities, and trash pickup have resumed in their neighborhood. How long would you recommend that your friends wait until returning to home?

a. I would recommend that my friends return after:

- ☐ 1 day
- ☐ 1 week
- ☐ 1 month
- ☐ 3 months
- ☐ 6 months
- ☐ 1 year
- ☐ 2 years
- ☐ 4 years
- ☐ more than 4 years
- ☐ I would recommend that they never return

b. According to Figure 2, the time period I indicated above means having an average life expectancy lost of approximately _____ days

Please explain your answer:

9. How important should each of the following factors be in the government's decision about how long to provide free housing for an evacuated household?

a. The cancer risk from the radioactive fallout in the evacuated neighborhood

1	2	3	4	5	6	7
Not important						Very important

b. The financial well-being of those evacuated

1	2	3	4	5	6	7
Not important						Very important

c. The quality of life in temporary housing

1	2	3	4	5	6	7
Not important						Very important

d. Whether evacuees believe it's safe to move back

1	2	3	4	5	6	7
Not important						Very important

e. The quality of the health insurance plan of those the evacuated household (in case they develop cancer)

1	2	3	4	5	6	7
Not important						Very important

f. The overall health of members of the evacuated household

1	2	3	4	5	6	7
Not important						Very important

g. The total number of households that need temporary housing

1	2	3	4	5	6	7
Not important						Very important

Please write down other factors relevant that should be relevant to the government's decision about how long to provide free housing, and rate the importance for each.

h. (describe) _____

1	2	3	4	5	6	7
Not important						Very important

i. (describe) _____

1	2	3	4	5	6	7
Not important						Very important

j. (describe) _____

1	2	3	4	5	6	7
Not important						Very important

Annex H: Numeracy measure

Please answer the following questions by filling in the blank

1. Imagine that we flip a fair coin 1,000 times. What is your best guess about how many times the coin would come up heads in 1,000 flips?

_____ times out of 1,000.
2. In the Big Bucks Lottery, the chance of winning a \$10 prize is 1%. What is your best guess about how many people would win a \$10 prize if 1000 people each buy a single ticket to Big Bucks?

_____ person(s) out of 1,000.
3. In Acme Publishing Sweepstakes, the chance of winning a car is 1 in 1,000. What percent of tickets to Acme Publishing Sweepstakes win a car?

_____ %

Annex I: Demographics questions

Please tell us a little bit about yourself.

1. How old are you? _____ years old
2. Are you _____ female _____ male
3. What is your highest grade of formal education?
 - ____ primary school
 - ____ some high school
 - ____ completed high school or GED
 - ____ some college
 - ____ completed bachelors (4 year) degree in college
 - ____ some graduate school
 - ____ masters or doctoral degree
4. What is your occupation? _____
5. What is your approximate annual household income?
 - ____ less than \$20,000
 - ____ \$20,000 to \$40,000
 - ____ \$40,000 to \$60,000
 - ____ \$60,000 to \$80,000
 - ____ more than \$80,000
6. Peoples' feelings of financial security vary with how much savings they have, how secure their job is, and how much debt they carry.
How comfortable do you feel about your overall financial situation?

1	2	3	4	5	6	7
Very insecure						Very secure
7. How would you rate the quality of your health insurance plan?

1	2	3	4	5	6	7
Very poor						Very good
8. Do you rent or own the home in which you live right now?
 - ____ rent _____ own
9. How long have you lived in the home in which you live right now?
 - ____ years and _____ months
10. How many people live in your current household, including yourself (count only those living with you for more than half the year)? _____

11. List the ages of each household member:

Member:	1	2	3	4	5	6	7	8
Age:								

12. Of those household members listed above, how many are children for whose care you are responsible? _____

13. What percentage of your overall extended family lives in [Southern Ontario, including Toronto / South-Western Pennsylvania, including Pittsburgh]? _____

14. Do you have friends or family outside of Southern Ontario, with whom you could imagine staying for an extended period of time? ____ yes ____ no

15. How would you describe your race? _____

16. What is your country of birth? _____

17. Is English your first language?

____ Yes

____ No, my first language is _____

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(U) The overall goal of this report is to improve understanding of public responses to domestic threats. Project 1 focuses on pandemic influenza and dirty bomb threats, aiming to understand the role of emotions in anticipated behavioural responses. Project 2 examines a situation in which people are evacuated from a community to avoid exposure to radioactive fallout from an upwind nuclear explosion. The project aims to understand the factors that affect people's decisions about how long to wait until returning to their homes, given the gradual decline in radiation levels resulting from radioactive decay.

First, we present an overview of each problem, by presenting models summarizing scientific knowledge. The resulting models use the logic of influence diagrams (Clemens, 1997; Fischhoff, 2000) with nodes reflecting relevant variables affecting the risk, and mitigating it, and links showing how they are connected. The models differ from traditional risk models, because they include emotional and behavioural components that affect how a risk event unfolds. Project 1 models concern the interplay between emotional and behavioural responses to domestic threats, focusing on fear and anger. The model for project 2 concerns the health, social, and economic factors that may affect people's decisions to return to a community with residual radiation levels that elevate cancer risk. Second, we report on surveys with Canadian and U.S. participants, based on these models. For project 1, we presented participants with scenarios describing the risks and mitigation strategies for pandemic influenza and radiological dispersion devices. We examined the independent relationship of fear and anger with different responses to these scenarios. We found that, independent of anger and trait emotions, fear was related to seeing more risk of morbidity and mortality, and predicting less resilience, more compliance with mitigation strategies, and higher likelihood of being absent from work in case of pandemic influenza. However, anger showed no significant relationship with these variables, after controlling for fear and trait emotions.

For project 2, the survey examined people's decisions about how long to stay evacuated before returning to a fallout-contaminated neighbourhood. We found that those decisions were affected by the cancer risk of radioactive fallout, as well as the availability of free housing in the evacuation zone. Although cancer risk was rated as the most important factor affecting these decisions (as was the overall health of participants and their household members), other characteristics of the household, the neighbourhood, and temporary housing were also rated as relatively important.

(U) Le présent rapport a pour objectif global de faire mieux comprendre les réactions du public aux menaces nationales. Le projet 1, qui se concentre sur les risques de pandémie de grippe et d'utilisation de bombe sale, vise à éclaircir le rôle des émotions dans les réactions comportementales attendues. Le projet 2, pour sa part, décrit un scénario où l'on évacue des personnes d'une collectivité pour prévenir leur exposition aux retombées radioactives d'une explosion nucléaire; il vise à explorer les facteurs qui influent sur les décisions des personnes concernant le temps à attendre avant de retourner à la maison, compte tenu de la baisse graduelle des taux de rayonnement résultant de la désintégration radioactive.

Nous présenterons d'abord un survol de chaque problème en nous appuyant sur des modèles résumant les connaissances scientifiques dans le domaine. Les modèles reposent sur la logique des diagrammes d'influence (Clemens, 1997; Fischhoff, 2000), dont les nœuds correspondent aux variables pertinentes qui influent sur le risque et le réduisent, et sur les liens montrant leurs interrelations. Ces modèles diffèrent des modèles

de risque classiques, car ils tiennent compte des facteurs émotionnels et comportementaux qui influent sur l'issue d'un incident. Les modèles du projet 1, qui concernent les liens réciproques entre les réactions émotionnelles et comportementales aux menaces nationales, se concentrent sur la peur et la colère. Le modèle du projet 2 concerne les facteurs sanitaires, sociaux et économiques qui influent sur la décision des personnes de retourner vivre dans une collectivité dont les taux de rayonnement résiduel augmentent le risque de cancer.

Ensuite, nous présenterons les études menées au Canada et aux États Unis à l'aide de ces modèles. Dans le projet 1, nous avons présenté aux participants des scénarios décrivant les risques de pandémie de grippe et d'utilisation de dispositif de dispersion radiologique, ainsi que les stratégies d'atténuation de ces risques. En examinant la relation indépendante entre la peur et la colère et les différentes réactions aux scénarios, nous avons noté qu'indépendamment des émotions liées aux traits de colère, la peur était associée à une augmentation du risque perçu de morbidité et de mortalité, de la conformité aux stratégies d'atténuation et de l'absentéisme au travail ainsi qu'à une diminution de la résilience en cas de pandémie de grippe. Cependant, dans le cas de la colère, nous n'avons relevé aucune relation notable avec ces variables après ajustement en fonction des émotions liées aux traits de peur.

L'étude du projet 2 consistait à observer les décisions des personnes concernant le temps à attendre avant de retourner vivre dans un quartier contaminé par des retombées radioactives. Nous avons noté que ces décisions sont influencées par le risque de cancer dû aux retombées radioactives ainsi que par l'accès à des logements gratuits dans la zone évacuée. Bien que le risque de cancer se soit avéré le plus important facteur à influencer sur ces décisions (de même que l'état de santé général des participants et des membres de leur ménage), d'autres caractéristiques du ménage, du quartier et des logements temporaires se sont aussi révélées importantes.

14. **KEYWORDS, DESCRIPTORS or IDENTIFIERS** (Technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus, e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus identified. If it is not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title.)

(U) Risk communication; public safety; compliance; avian flu pandemic; radiological/nuclear attack; emotions; influence models; public decision making

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